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EDITORIALS

Technical Committee Functions

SOMEONE has raised a question as to how technical committees of the American Society of Agricultural Engineers might be organized and their work distributed and planned to get it done most effectively.

Committee organization is no substitute for work. It is only a means to an end. Therefore it seems that analysis of committee jobs is a prerequisite to any consideration of the possibilities of improving the mechanics of the whole committee setup. The jobs to be done and practical considerations of getting them done, rather than any hard and fast rules or fixed forms of committee organization and procedure, should dictate ways and means.

What is the function of a technical committee in the A.S.A.E.? If a committee is not quite sure what it might best undertake, how might it proceed to analyze its job?

From a review of definitions and purposes, we submit as a major premise that the job of a technical committee in the A.S.A.E., in terms of fundamentals, is to help agricultural engineers serve farmers, related industries and sciences, and the general public more effectively with respect to the particular subject matter of the committee. This subject matter will be in the field of present or prospective agricultural engineering technology or its applications.

Analyzing this job into its separate factors, it involves determining what help agricultural engineers may need most, deciding how that help may be provided, and initiating and pushing the indicated action to provide it.

What help may agricultural engineers need in order to serve more effectively? Does the subject matter of the committee involve one or more clearly defined bottlenecks in agricultural engineering service? Or does it present some apparent new or newly recognized opportunities which should be called to the attention of agricultural engineers? Does the daily work of agricultural engineers in this field bring to light all of its problems and opportunities? Or is their progress slower than might be expected, due to some obscure, neglected, important factor? With respect to the technology, or the farm or commercial problem or opportunity involved, does increased or improved engineering service await a more thorough analysis of its possibilities, limitations, or methods of approach? To what extent is agricultural engineering service, in the field of the committee, sensitive to modification by new developments in other phases of agricultural engineering, in related fields of science and engineering, in materials and equipment, or in farm practice? Is a standing "watchdog" committee needed to be continually on the alert for these new developments which might modify the problems and opportunities of agricultural engineers?

Can the committee be most helpful as a service committee, or as a steering committee, or both? Can it be most helpful by concentrating its efforts on evident unfinished work at hand; or by looking for more work, taking the initiative in analyzing the problems and opportunities of its particular field in relation to other phases of agricultural engineering and the general trend of agricultural, technical, commercial, and human progress?

From another angle, do agricultural engineers need the help of the committee from the standpoint of improving their technology? Or in getting the results of sound technology accepted and applied by farmers or commercial interests? Or in guarding against any unsound, unfavorable, or dangerous interpretation or misapplication of their technology?

With respect to improving the technology, is there a lack of basic data from other fields; of basic data which agricultural engineering research might produce; or of application by agricultural engineers of basic data already available? Is there a need of making new data more quickly and readily available? Are agricultural engineers talking about the committee subject in a babel of tongues which indicate need of standardization or definition of terminology or technical method?

With respect to promoting sound applications and preventing misapplications, is there a need for more or better extension material; a new or more selective approach to users; or standards or specifications which commercial interests will observe and support? Is there a possibility of giving greater recognition to related farming, commercial, and personal considerations influencing applications?

If a technical committee can thus classify the ways in which it might be helpful to agricultural engineers, necessary action may become self-evident. Where only agricultural engineers are involved, a compilation of data or an analysis of a situation, published with recommendations, may be all that is required. In other cases, the completion and filing of a committee report, and its publication, will fall far short of providing the desired help. Other members of the Society and various public or commercial administrators and leaders in related fields may have to be convinced and their active support obtained.

The Society has limited publication facilities and almost no other facilities by which it can directly accomplish more than a vocal or ink-and-paper job of helping agricultural engineers to do more and better work. But it and its members have some valuable contacts and a strong professional influence through which its committee recommendations can generally be carried to their logical conclusion. Analysis of its job by each committee, and continued pressure from within the committee to get action on its recommendations, is the foundation of effective committee work.

Problem of the Low Producer

AGRICULTURE and agricultural engineers share with the general public the problem of the low producer—the "sub-subsistence" individual who has not used, or who cannot or will not use, the help developed and offered by technology and industry to increase his effectiveness as a producer of genuine economic goods and services.

That the low producer is a social and economic liability to his fellow men is too well known to require amplification. The question is what to do about him. It costs a lot to do nothing about him. Even from the most hard-boiled, selfish, or realistic viewpoint there is a real possibility that it may cost society less in many cases, and be otherwise desirable, to help him improve his effectiveness as a producer. It may take him off of charity and relief, reduce his contribution to the cost of crime and disease, and make him a better customer, supplier, employee, or taxpayer. It may even make him a cleaner, more worthy competitor.

In agriculture, perhaps more than in many other lines of production, there are low producers who are far from hopeless dependents of society. Many of them are low producers, not because of any inherent limitation of fitness for the job, but because they are working under handicaps. Some are young and starting short of capital, backing, training, or experience. Some have been victims of drought, floods, fire, and other disasters. *(Continued on page 116)*

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Machines and Jobs

By Leonard J. Fletcher

FELLOW A.S.A.E.

HAVE you ever made an effort to determine the facts concerning machines and jobs? After diving through the froth of generalities, unsupported statements, and personal opinions, draped to appear as logic, you will find nothing in fact or sound reasoning to support the oftrepeated statement that machines or technology cause unemployment.

Yet the mistaken idea that machines cause unemployment seems to have taken hold, considerable evidence of which may be found in the statements and proposals of so-called responsible persons in high places. As one example, a member of the United States Senate is in favor of national legislation which will tax all members of an industry making more than "normal" use of technological developments, giving the proceeds directly to other members of the same industry which are less completely mechanized. In other words, a reward for inefficiency, consisting of proceeds from a tax not paid by the affected industries, but a tax paid by every buyer when he buys his shoes, clothing, furniture, or any other manufactured commodity. This proposal would amount to a decrease in the wages of every man who works.

But continuing our search for facts, on no account do machines lose. The most highly mechanized industries today have the highest rate of employment, while the least mechanized are suffering from the greatest unemployment. For example, the building trades have low relative employment even though a shortage exists in housing.

The per cent of our population gainfully employed has risen steadily from 32.7 per cent in 1870 to 40.7 per cent in 1930. This is not in spite of, but because of the advance of mechanization. Working with machines, men produce more and better products in a given time. Prices are lowered because costs are less and low prices invite buyers. The free buyer therefore chooses to spend his money where he obtains the best value, that is, for the products of mechanization. Thus more things that people want are purchased and more men are employed to produce them.

In AGRICULTURAL ENGINEERING for October 1933, there is published a paper which I prepared on the subject, "The Real Effects of Mechanization on Wheat Production." This paper analyzes the subject from several viewpoints. It shows that much of the former heavy hand labor of agriculture, with its long hours, has been transferred to the mechanical-power-using labor of the factory. On a typical family-operated grain farm of 500 acres in wheat and 500 acres in summer fallow, it is shown that 1400 hours of work on the farm by the father and one son produced the crop, while 2600 hours were employed in off-the-farm labor in factories, mines, oil fields, local shops and railroads. Thus 4000 hours, not 1400 hours, of labor actually were devoted to the mechanical production of this wheat.

In the 1932 U. S. Yearbook of Agriculture (page 498), there is a table showing the changes that have taken place in the number of agricultural workers in this country. It is shown that there were 1,015,000 fewer males over ten years of age engaged in agriculture in 1930 than there were in 1910. Let us examine further. We learn that but 8 per cent of this decrease is in paid agricultural workers and that 92 per cent of the decrease is in unpaid family workers. In other words, farm mechanization largely can be credited with the liberation from toil of nearly one million unpaid farm family workers.

Let us visualize what this really means. In the earlier days of hand production, the work of the younger children

Paper read before the A.S.A.E. Industry Seminar at Peoria, Ill., September 6, 1940. Author: Assistant general sales manager, Caterpillar Tractor Company.

The carrying out of the important soil conservation program now under way in America would be seriously handicapped if efficient earth-moving machines were not available

and old people was necessary to handle the ever-recurring peak loads in the field. This great group of unpaid family workers, now relieved from work in the fields, is largely made up of these younger children and old people. Farm machinery to them means a better physical start in life, a good education, and relief from toil in old age.

Let those who clamor for the good old days, cut hay with a scythe all day in the hot sun. If this worker shows up at all the second day it will be on the seat of a mower, or more likely he will be found on the cushioned seat of an air-conditioned, streamlined train on his way to more "pointing with alarm."

A report (No. A-9) of a national research project of the Works Progress Administration, entitled "Tractors, Trucks and Automobiles", contains complete information showing that while the introduction in agriculture of the three above-mentioned machines reduced the number of man-hours of work per year on farms by over one billion, the number of man-hours employed per year in nonfarming areas to produce and maintain these units is over 1,400,000,000. There is thus a machine-induced increase of 400 million man-hours of work per year.

Who blames the machine for unemployment do you say? Several types of people, but mainly those who look for the most apparent cause for any effect; the nearest cure for any trouble; the type who scratch their poison ivy. Then we have those few who are deliberately trying to develop deep unrest among the people of this nation and use every possible means to gain their ends. In addition, these few do not seek the headlines; they mainly work under cover through others.

SUBSTITUTING MEN FOR MECHANICAL POWER UNITS

Come with me on a little mechanical venture in the factory of the company I represent. Let us assume that we had been directed to produce the same quality and same number of machines as at present, but on certain jobs do away with mechanization. Not entirely, but simply to the point where more men could be employed.

In our factory you will find many men employing small electric or air hoists to lift parts onto or from machines. You will also find gas-electric trucks carrying semifinished and finished parts about the plant. You may find a tractor hauling a long train of small steel cars. You will also occasionally find a man pushing a hand truck, or perhaps using a hand-operated hoist. In these latter cases, the amount of work done in a day, or the effort required, made hand use preferable to mechanical. However, it would be physically possible for us to do this lifting of certain parts by hand hoists, and we could convey the product through the aisles of the plant with hand-pushed or pulled vehicles. This could be done and yet allow us to build practically as good a product as we now produce.

But what would be the result? We have carefully estimated the amount of work done by these hoists and trucks and find that to do the minor lifting in the plant and to transport material within the plant, there is each day consumed a total of 8900 hp-hr of energy.

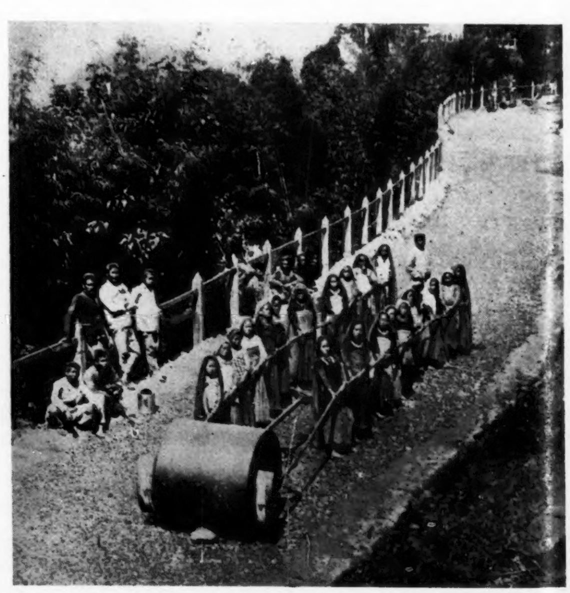
A man can develop about one-tenth as much power as a horse. This has been proved by a number of scientific tests in various parts of this country. Thus a man developing one-tenth hp would in an 8-hour day develop a little less than 1 hp-hr. It would appear, therefore, as though these hoists and trucks took the place of 8900 men. On the other hand, the men who are now operating the mechanical hoists and trucks, by working much harder, could do a certain amount of work themselves by hand. So we will assume that they would do about one-third of this work, making it necessary, therefore, to add about 5000 men to do the remainder.

Now let us see just what would be the result. It should be obvious to everyone that manufacturers want to produce good products and sell them to a maximum number of customers. But another major objective resulting from volume sales is furnishing good, steady employment to a maximum number of people. So the first observation might be a great sense of gratification over this employment of 5000 more men. However, this heavy lifting and carrying would involve greatly increased physical hazards, a fact overlooked by many.

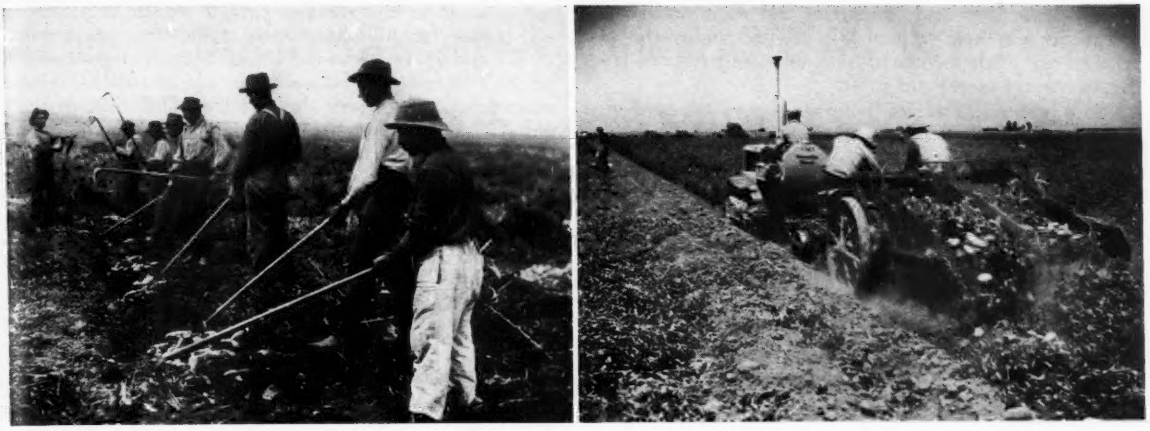
Let us look further. People who buy our products are free to select whatever make they choose. The primary reason that people employ our machinery is so they can accomplish a job at a lower cost. It is therefore obvious that the price they pay for the machines is a very considerable factor in their choice of using machines built at our factory, machines built elsewhere, or using machines at all.

If we were to pay these 5000 men just what it cost us to employ the mechanical units, they would earn about ten cents a day, because that is, if anything, a high figure for the cost per horsepower-hour of the energy used in our hoists and trucks. If you investigate the pay of a Chinese coolie pumping by hand water for irrigation, or digging up the surface of a field with a hoe, you will find his pay is not far from ten cents a day. It is obvious that in this day and age no manufacturer could pay such a small wage —in fact, it is unlawful.

People who are asking that hand labor be employed in place of machinery, in every case assume that the worker will be given what is considered to be a living wage, and at least the equivalent to that of other men in the plant who are doing similar hand work. Let us assume, therefore, that the men in this plant will be paid our minimum hourly wage, which would return to them an annual income of about $1300. Thus, 5000 men at $1300 a year means a clear addition of $6,500,000 must be added to our costs without increasing the volume or quality of our product.



Which builds a better civilization, human beings used as beasts of burden, as in pulling this road roller, or men at the controls of modern road machinery? Let us think well before we interfere with the technological progress in this country



There is no half-way retreat from mechanization. Either we go forward, utilizing our resources of power, materials, inventiveness, and skill, or we go backward all the way to a complete hand economy

Taken over a period of years, this is more than our earnings—more than our dividends.

Of course, this hand labor plan would also be introduced into the production of the steel and other raw and semifinished material we buy, to the end that the selling price of our product would be greatly increased. The net result would be a material reduction in sales and a reduction in number of all types of employees, to the end that many less than our present number of employees would find work here. When more hours of work are devoted to producing the same amount of any product, the price to the buyer in dollars or in terms of hours of his labor must go up. Thus we spend more and more time producing less and less, until we have turned the clock backwards to complete hand economy and scarcity.

Is it not thus evident that the only path for this country to take is to continue to employ efficient methods so that we can produce more with less effort? After all a high standard of living consists simply of having things we want, and we cannot have these things unless they are first produced or manufactured. We must have confidence that the system which has brought this country into its position of leadership in the world will continue to work. In fact, it is continuing every day.

It is rather obvious that if this thoughtless move to penalize the use of efficient machines should gain headway, one of the first to suffer would be the men employed in this and all other similar factories, for the reason that the machines produced are all intended to do some job more efficiently, with less effort and cost than with methods formerly employed. A factory machine operator recently told me that he should have quit the job he had six years ago and secured a job in another plant, for the reason that his plant instead of utilizing modern machine tools was continuing the use of old boring mills, lathes, and presses. He noticed that the plants that were continually improving their equipment, were hiring men, building more products, finding new markets, while those staying with the old methods were slowly going backwards. Modern machines make jobs. Check this in your community.

These assumed orders to substitute hand for machine work are not entirely fantastic. In a paper read before a highway conference at the University of Colorado in January, 1940, F. A. Nikirk, civil engineer of our company, presented a chart on which he showed the bid price per cubic yard of earth moved on federal-aid projects from 1923 to 1938. He also showed the hourly wage of common labor for the same period. Taking 1923 as a base, which, according to Mr. Nikirk, was a period of manual labor and animal power in earth moving, it was shown that in 1938 the bid price per yard was 46 per cent of that bid in 1923, while the hourly wages of common labor had increased 131 per cent. However, the significant part of this curve has to do with the period from 1932 to 1935, which is known as the period of government regulation requiring a fixed number of man-hours per unit of work done. During this four-year period the bid price per cubic yard rose over 55 per cent.

A case is known of a contractor making the low bid on a road improvement job on which a fixed number of man-hours had to be employed per unit of work done. Instead of placing wheelbarrows and shovels in the hands of the men, he asked most of them to sit around the sidelines while he did the work with the equipment provided him by modern technology. In other words, he could afford to pay many of the men to do nothing, add this labor charge to his low cost of mechanical earth moving, and yet be low bidder.

All of us have seen the present-day method of moving earth with shovels, picks, and wheelbarrows, very likely quite similar to the method employed 6000 years ago when an Egyptian king directed 100,000 men to labor 20 years building a great pyramid. It is estimated this pyramid contains 7,000,000 tons of stone. The pyramid was the tomb of a king and a civilization.

The one million Indians who once occupied the area now included in the continental United States were constantly facing starvation, disease, and insecurity. Why? They had all our present natural resources and more. They displayed much intelligence in many of their activities. They lived here a long time. It may be significant that a kind historian, describing their virtues, wrote: "The American Indian exceeds the inhabitants of Europe in his self-denial and ability to suffer uncomplainingly." It is well that we remember these virtues for they belong to a people who owned all property in common, were strictly guided by a chieftain, and had no incentive to exert themselves or develop the resources of their land. Today this same land supports its 130 million inhabitants far above the living standards of any totalitarian state.

The land of the American Indian was discovered by men looking for an easier way to India. Europeans knew where India was—they had been there, and it was quite proper that they attempt to find an easier and more direct

route. While they made important and most worth-while discoveries on their western trip to find India, the fact remains that the best route to India ultimately resulted from the improving of the old route.

So it is with this way of living which we have developed in this country. It is only natural that an energetic, creative people should desire ever better things for themselves. Here we have technology coupled with great natural resources and a system of free enterprise to thank for the highest standard of living yet attained by any people in the world. At the same time in the face of this demonstrated accomplishment, technology and free enterprise have both been attacked. It is surprising that someone has not come forth with the thesis that our great natural resources are a curse instead of a blessing, and that we would be far better off living in a desert so as to keep continually hard and hungry. How ridiculous it is to hold up as a goal of civilization a way of life which requires people to practice self-denial and "suffer uncomplainingly"!

As long as we develop new technical processes, produce vast quantities of goods and ever improve the life of our people, no one need fear of our ever becoming soft. The machine does not build, improve, or operate itself and requires the everconstant time and energy of thinking and working men. Softness comes only when that type of national cowardice develops which shirks the responsibility of maintaining in happiness a growing civilization, taking advantage of all that machines can offer.

WHO WANTS TO ABOLISH THE MACHINE

But why is it some people seem willing to turn away from the very system of free enterprise which has given them so much? Why are they ready to trade this free opportunity to advance to any height their ability allows for an unknown system, or one already proven a failure in other countries? Why do people think we have finished our growth and development? This attitude is not natural to an American. We are not a nation of quitters in our sports or other contests of brain or brawn. Why do so many people believe the false logic or misstatements concerning our national affairs, when these statements do not square with their own personal experiences? Everyone wants for himself the products of the machine—the electric lights and household appliances, running water, fast transportation, good highways, motion pictures, the telephone, the radio, good clothes, comfortable furniture, all products of mechanization. How many individuals do you know who have more than they want? Name one. Why then this idea that we suffer from over production, too much technology, that we must stop invention, declare a patent holiday, turn back to the old handicraft?

The fact is established that given full employment in this country, the increased consumption of meats, dairy products, fruits, and fresh vegetables will employ many of the present idle acres and greatly increase farm income, which is the very foundation of our prosperity. True, everyone in this country is supplied with food today, but one-half an acre will provide one person a year's food supply, if he eats bread and potatoes, while the products of over 2 acres are needed if he has the income to supplement his bread and potatoes with all the other healthful foods he needs and desires. Machines allow greater production per hour; they result in increased pay to employees and lower prices to buyers.

Let me give you an example of prosperity through technology at work. In a recent address before the national Pioneer's Committee dinner, Robert L. Lund stated: "There were 1099 patents issued to Thomas A. Edison. Developments based on his invention provide wealth, employment, and culture for millions of men. Economists estimate that 26 billions of wealth in the United States has grown from Edison's ideas, that 7 billion of our annual national income arises from employment they created. One man in every nine in industry owes his job to Edison's genius."

Some point out that in the nation as a whole machines make jobs, but that individuals are left stranded with no work when machines come into any certain community. Most people accept this information without question, but there is a great lack of evidence that this is the case in many places or with many people.

A certain movie pictured the tractor as driving Oklahoma farmers to California. Facts, of course, mean nothing to the writer of fiction, but most people accepted this picture as at least based on truth. Dr. O. D. Duncan of the department of sociology of Oklahoma A. & M. College, in a recent bulletin (No. 88), points out that actual surveys of thousands of emigrants show that 44 per cent left Oklahoma because of drought, 43 per cent to find better jobs, and less than 2 per cent said they were replaced by machines. At that, two parts of truth per hundred is better than most of the propaganda against the machine.

Consider the public acclaim given to the great painter, musician, singer, or actor. The world applauds their talent and is little concerned with the size of their income. We know these people are using their skill and their ability for the benefit of those who live about them. Why not, therefore, give similar acclaim to the skill of the foreman, superintendent, or manager in our factories, most of whom have advanced from unskilled occupations, up all the steps, to the management of a business or industrial enterprise? These men also have a rare ability. They work not with paints, or stone, or musical instruments, but rather with people and machines. They have the rare ability to imagine, to invent, to organize, to give work to others, and to provide those things which give all of us a better living.

FACTS SHOW THAT MACHINES CREATE JOBS

In the thought-provoking book, entitled "Smoke Screen", by Samuel D. Pettengill, a former member of Congress from Indiana, the author states: "Why, then, 8,000,000 unemployed in the richest country in the world as we still struggle for recovery, in the eleventh year since the Great Wind of 1929? Economic nationalism and a gradually closing world economy have admittedly added to our difficulties as a long-time exporting nation, although, as previously stated, the world has recovered from the valley of 1932 faster and more than we. But on our own side of the Atlantic what domestic reasons exist? Has it been due to the machine—technological unemployment? At one time I gave this a position of importance, but I now think I was in error. . . . . On net balance, it seems certain that the machine creates more jobs than it destroys. As the axe to the frontiersman, the net to the fisherman, the plow in place of the crooked stick, the mine hoist in place of the backs of mules or children, the machinery of peace cannot be considered the enemy of man."

What is the technique of those who condemn the machine? First, they attack the inanimate "monster", the machine. What is the machine? In its many parts it is a product of invention, of men who work and produce so others may have a better life. The machine could not exist without its inventor, a *man*; its operator, a *man*; management of *men* to organize its use and sell its products, and capital, the preserved labor of the *men* of yesterday, to bring it into being and supply it with raw material. Why do not these people who condemn *(Continued on page 92)*

The Uniformity of Application of Water by Sprinkler Systems

By J. E. Christiansen
MEMBER A.S.A.E.

THE purpose of a sprinkler is to distribute water over the surface of the soil in such a manner that there can be absorption without runoff. Preferably, distribution over the area should be uniform, in a qualitative sense. Although an absolutely uniform application is not possible, it can be approached under field conditions. The degree of uniformity is affected by many factors and varies over wide limits. It depends largely upon the spacing of the sprinklers and upon wind, pressure, speed, and uniformity of rotation and similar factors.

Many tests have been made to determine the uniformity of distribution. Manufacturers generally maintain facilities for testing sprinklers and for making adjustments to obtain the desired distribution. Staebner[1] conducted a series of tests on both American and German sprinklers. Extensive tests have also been made in Germany. One main difficulty has been a lack of any standard procedure for analyzing and reporting the data. Staebner judged the sprinklers tested on their ability to distribute water so that the maximum depth was not more than twice the minimum, except near the edges of the area covered. He did not, however, discuss overlap or the spacing of sprinklers for best performance. He states: "No matter how successfully they may distribute water over a circular area, they leave much to be desired, because if circles just touch one another, a considerable area is left unwatered, and if they overlap, a great amount of double coverage results."

In a general investigation of sprinkling as a method of irrigating agricultural crops[2], the distribution of water from sprinklers and the importance of proper spacing were investigated. This study has included more than 300 tests on sprinklers, analyses of the data to determine the uniformity of distribution for various spacings, and consideration of geometrical patterns to determine desirable patterns and their relation to spacing.

More than 200 sprinkler tests have been made on large sprinklers of the types used in portable agricultural systems and for golf courses and large lawns. Some 50 additional tests were made on lawn sprays, and about fifty more on small sprinklers of the types used in portable orchard systems[3]. For most of these tests the sprinklers were operated for one hour (for others, 30 min), and the water was caught in cans spaced 10 ft apart (or closer) over the entire area covered. In certain tests 280 cans were used. The water caught was measured with a graduate to the nearest cubic centimeter, equivalent to 1/200 in depth. For most of the tests, wet-and-dry bulb temperatures were recorded and wind velocities determined. For many of the tests the rate of sprinkler rotation was obtained continuously with a graphical recorder. Each test was plotted to a scale of 1 in to 20 ft. A plan view[2] shows contours of equal intensities. Cross sections in both north-south and east-west directions show how intensities vary at different distances from the sprinkler.

The cross sections for eight typical tests representing different conditions are shown in Fig. 1. Tests 16, 132, and 170 are cross sections of patterns for different sprinklers operating under favorable conditions, that is, adequate pressure (40 to 50 psi), low wind velocities (less than 3.0 mph), and slow and uniform speeds of rotation. Patterns, conical in shape, as illustrated by test 170, produce very uniform applications when the sprinklers are properly spaced. Test 11 shows what happens when the pressure is inadequate (20 psi). Most of the water is deposited in a ring 35 to 40 ft from the sprinkler. Tests 112 and 88 illustrate the effect of wind (10 to 14 mph). The patterns are unsymmetrical, with a high intensity near the sprinkler. Test 118 illustrates a high rate of rotation (26.3 rpm average). Sprinklers of this type normally rotate at a speed of less than 1.0 rpm. Rapid rotation greatly reduces the area covered and correspondingly increases the actual rate of application. The discharge of the sprinkler was 22.1 gpm, as compared with 19.7 gpm for test 16, where the maximum intensity was about 0.30 in per hr. Test 103 illustrates the effect of variation in the angular velocity of the sprinkler. The lower figure shows the average angular velocity for different positions of the main nozzle, indicating a variation from about 0.3 to 1.5 rpm. The actual intensity of application varied from about 0.10 in per hr north of the sprinkler to more than 0.6 in per hr to the southwest of the sprinkler. The resulting application from a group of sprinklers behaving like this one would be far from uniform.

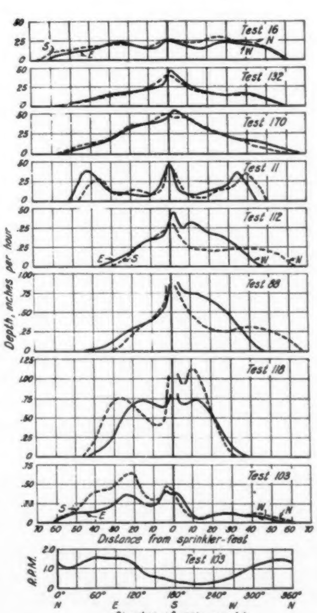


Fig. 1 Cross sections of eight typical sprinkler patterns, representing different operating conditions

These patterns show the general characteristics of sprinklers operating under different conditions, but they tell us little about the uniformity of distribution over a large area covered by several sprinklers. This uniformity depends upon the spacing and the overlap. Most of the portable systems use sprinklers mounted 20, 30, or 40 ft apart along the pipe line; and lines are generally moved from 40 to 80 ft. Since most of the sprinklers cover areas 100 ft or more in diameter, there is considerable overlap, and any one point may receive water from several sprinklers. The distribution resulting from two patterns

Presented at a joint session of the Rural Electric and the Soil and Water Conservation Divisions at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 5, 1940 Author: Assistant irrigation engineer, University of California.

[1] Staebner, F. E. Tests on spray irrigation equipment, U.S.D.A. Cir. 195, pp. 1-29 (1931).

[2] Christiansen, J. E. Irrigation by sprinkling. Agr. Engr. 18(12):533-538 (Dec. 1937).

[3] Christiansen, J. E. Portable drag-type sprinkler unit for orchards. Agr. Engr. 21(5):182, 186 (May 1940).

(tests 11 and 16) with sprinklers spaced 40x50 ft apart, was illustrated in a previous paper[2].

To compare sprinkler patterns and to determine how various spacings affect the resulting distribution of water, one needs a numerical expression that can serve as an index of the uniformity secured. For this purpose, I use an expression I call the "uniformity coefficient" C_u. The uniformity coefficient expressed as a percentage is defined by the equation

$$C_u = 100\left(1 - \frac{\Sigma d}{mn}\right)$$

where d is the deviation of individual observations from the mean value m, and n is the number of observations. An absolutely uniform application is then represented by a uniformity coefficient of 100 per cent; a less uniform application, by some lower percentage.

When the intensity of application at any number of equally spaced points over the entire area covered by a sprinkler is determined, the uniformity coefficient can be computed for any spacing (in either direction) which is a multiple of the spacing of the points of observation. Thus a complete analysis of one sprinkler pattern to determine the best spacing and the resulting uniformity of application involves numerous computations.

So that all the tests might be analyzed, the problem of determining the proper spacing for best distribution was simplified by calculating the uniformity coefficients for a close spacing in one direction by various spacings in the other direction. Most of the tests were analyzed for spacings of 10 ft in one direction by 40 to 100 ft in the other direction. Since the patterns were not symmetrical, uniformity coefficients were determined for both directions, and mean values were used. Some of the tests were also analyzed for various spacings along the line by spacings of 40 to 100 ft between lines. The results of such an analysis for six of the patterns shown in Fig. 1 are given in Table 1. This table shows how the uniformity coefficients vary for the same spacing between lines, when the spacing along the line is varied. The relation between the uniformity coefficient for a spacing of 10x60 ft and for one of 60x60 ft appears to depend entirely upon characteristics of the pattern. With test 11, for example, the uniformity coefficient drops appreciably with an increase in spacing along the line, whereas with test 170 it remains fairly constant for a spacing up to 60 ft. Notice also how the uniformity coefficients vary when the spacing between lines is varied, holding the spacing along the line constant. For test 16 and a line spacing of 40 ft, the uniformity coefficient varies from a maximum of 94 for a spacing between lines of 40 ft, to a minimum of 88 for 60 and 70-ft spacings, and back up to 91 for a spacing of 80 ft. With a spacing between lines of 80 ft, the overlap is about right; but for a spacing of 60 or 70 ft, excessive overlap occurs. When the spacing is reduced to 40 or 50 ft, better distribution is obtained as a result of double overlap. With a conical type pattern (Fig. 1, test 170) the permissible spacing is less; but for any spacing up to the maximum desirable, the uniformity coefficient is exceptionally high. The uniformity coefficients for test 88, showing the performance of a sprinkler under an average wind velocity of 10.7 mph, and for test 118, where the sprinkler rotated rapidly (26.3 rpm), indicate to what extent the effective area covered is reduced when operating conditions are unfavorable. For both these tests the size of sprinkler nozzles and other factors were comparable with tests 16 and 170, but the maximum desirable spacing was reduced to 60 ft for test 88, and 40 ft for test 118.

To determine the most desirable type of sprinkler pattern, many geometrical patterns were analyzed in a similar manner. Fig. 2 shows the results of such an analysis for six shapes, characteristic of some of the actual patterns obtained. These patterns can be placed in two groups: A, B, and C, for which the application tapers gradually to the edge of the area wetted; and D, E, and F, for which the application is fairly uniform over most of the area covered. For the first three, fairly high uniformity coefficients are obtained for line spacings up to about 60 per cent of the diameter covered, beyond which they drop off rapidly. For the latter three, the uniformity coefficients are fairly high up to a spacing between lines of about 45 per cent of the diameter, and are fairly high again for spacings between 75 and 85 per cent; but for spacings between 45 and 75 per cent, they are low. Since wind, speed of rotation, and other factors have an appreciable effect upon the actual area covered by a sprinkler, it is difficult to space sprinklers in such a way as to take advantage of the wider spacing.

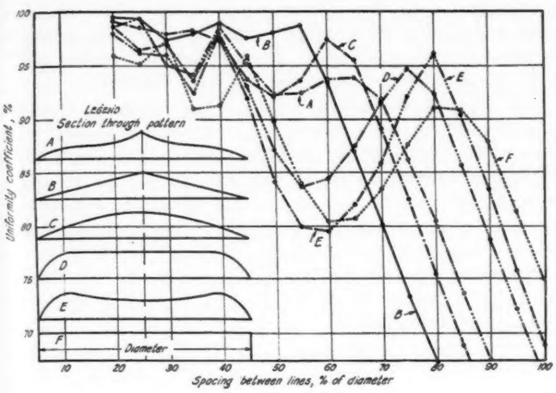
TABLE 1. UNIFORMITY COEFFICIENTS FOR ACTUAL SPRINKLER PATTERNS WITH DIFFERENT SPACINGS OF SPRINKLERS

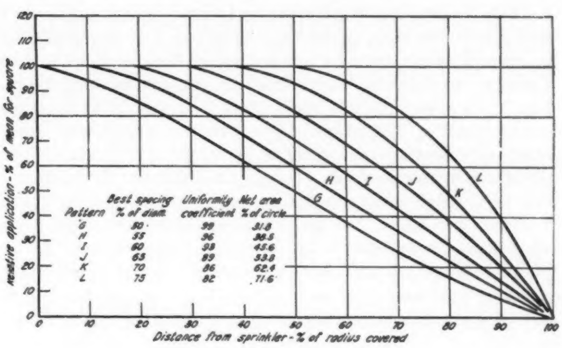
Spacing along line, ft	Spacing between lines, ft: 40	50	60	70	80	90	100
			Pattern for Test No. 11				
10	90	77	69	76	89	81	
20	79	77	65	65	72	66	
30	86	73	68	72	78	70	
40	76	56	45	50	57	52	
60		57	53	46	49	42	
60-S*		56	47	41	51	42	
			Pattern for Test No. 16				
10	96	95	89	88	93	92	82
20	95	95	89	88	93	92	81
30	93	94	89	88	91	90	81
40	94	92	88	88	91	89	81
60		84	82	83	83	82	74
60-S		90	84	81	82	79	74
80			84	80	78	75	70
80-S			75	76	76	76	73
			Pattern for Test No. 88				
10	93	93	95	83	68		
20	91	92	94	83	68		
30	90	90	92	83	68		
40	85	85	84	79	66		
60		75	71	71	60		
60-S		72	77	71	60		
			Pattern for Test No. 118				
10	96	87	68	50			
20	93	87	68	50			
30	85	81	66	49			
40	84	78	63	48			
60	72	72	62	44			
60-S	82	79	61	44			
			Pattern for Test No. 132				
10	90	97	94	90	86	80	
20	90	96	94	90	86	80	
30	89	95	92	90	86	79	
40	89	91	90	88	85	79	
60		89	88	87	83	76	
60-S		91	89	86	83	77	
80			82	83	78	74	
80-S			86	85	82	75	
			Pattern for Test No. 170				
10	98	96	95	91	81	69	59
20	97	96	95	92	80	69	59
30	97	96	94	91	80	69	59
40	96	95	94	90	80	69	58
60		94	93	89	80	69	58
60-S		93	92	89	80	69	60
80			79	79	75	66	57
80-S			89	86	77	66	57

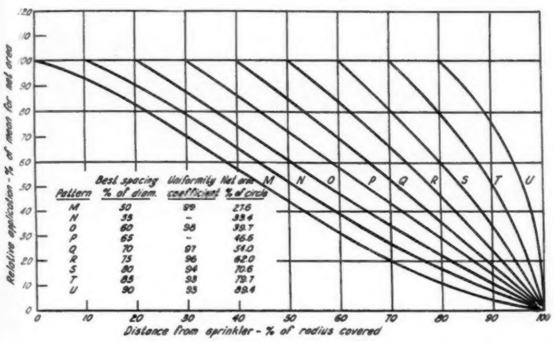
*S indicates staggered or triangular arrangement.

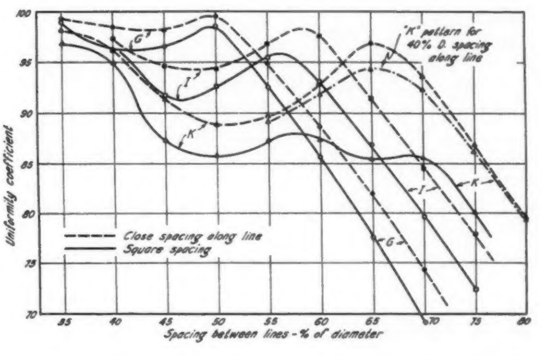
Pattern B apparently gives the best results for all spacings up to 55 per cent of the diameter covered, but should not be used for wider spacings. Fig. 2 does not tell the complete story, however, because the analysis is based on a very close spacing along the line (.05 D) which is not practical, but it does show the characteristics of the patterns.

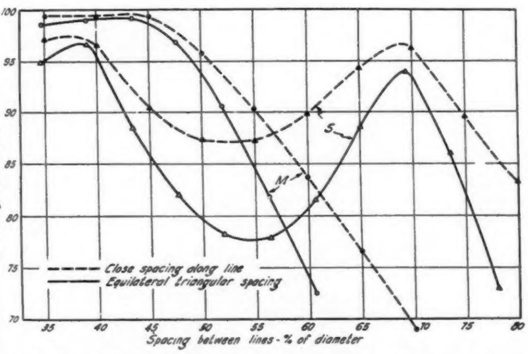
Figs. 3 and 4 show the results of a study to determine what patterns will give the most uniform application when











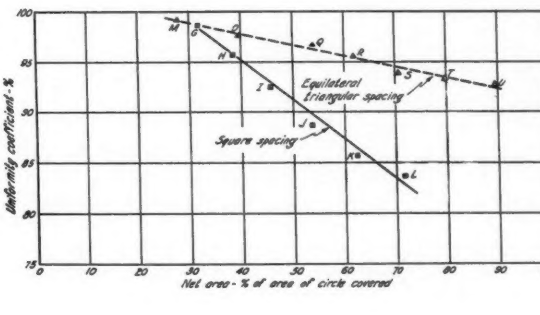


Fig. 2 (Top, left) Six geometrical sprinkler patterns and uniformity coefficients for a close spacing along the line (.05D) by various spacings between lines. Fig. 3 (Top, right) Half cross sections of patterns that give highest uniformity coefficients for different spacings of sprinklers when arranged in a square, that is, where the spacing is the same in both directions, and sprinklers are in straight rows normal to each other. Fig. 4 (Center, left) Half cross sections of patterns that give highest uniformity coefficients for equilateral triangular arrangement of sprinklers. The spacing given is the spacing along the line; the spacing between lines is 86.6 per cent of the spacing along the line. Fig. 5 (Center, right) Uniformity coefficients for patterns G, I, and K (Fig. 3) for different sprinkler spacings, in per cent of the diameter of the pattern. Fig. 6 (Bottom, left) Uniformity coefficients for patterns M and S (Fig. 4) for different spacings. Fig. 7 (Bottom, right) Comparison of highest obtainable uniformity coefficients for square and equilateral triangular arrangements of sprinklers. Lettered points correspond to patterns shown in Figs. 3 and 4

the sprinklers are placed in a square or equilateral triangular arrangement with the spacings exceeding 50 per cent of the diameter. The shapes of these patterns which gave the highest obtainable uniformity coefficients were determined by trial and error.

When any of these patterns are spaced or arranged differently from that for which maximum uniformity coefficients are obtained, the resulting application will generally be less uniform. For example, Fig. 5 shows what happens when patterns corresponding to curves G, I, and K (Fig. 3), are spaced different distances apart. The broken curves show the uniformity coefficients for an arrangement of sprinklers corresponding to a very close spacing along the line, with the lines spaced various distances, whereas, the solid lines are for sprinklers arranged in a square, that is, where spacing along line is same as spacing between lines. Fig. 6 is a similar set of curves for patterns S and M, Fig. 4. Note particularly in this case that for pattern S (pattern giving highest coefficient for a spacing of 70 per cent of diameter, with triangular arrangement) the uniformity coefficient drops from 94 per cent for spacing of 0.7 D to 78 per cent for spacing of 0.55 D. This illustrates the effect of excessive overlap, where better results could be obtained by spacing the sprinklers farther apart. Note that the spacings, for which the uniformity coefficient is high, are very limited; in other words, C_u is greater than 90 per cent only for spacings less than 0.45 D and between 0.66 D and 0.72 D.

Fig. 7 shows a comparison of the highest uniformity coefficients for both square and triangular arrangements of sprinklers. For spacings not exceeding 50 per cent of the diameter covered by the sprinkler (points M and G on Fig. 7), a very uniform application is possible with either arrangement of sprinklers. For wider spacings, the equilateral triangular arrangement is superior, provided the pattern is correct and the spacing is suitable for that pattern. The triangular arrangement is more sensitive to spacing, however, and unless the sprinklers are accurately spaced, no advantage may result. Because the area covered by a sprinkler is greatly affected by wind and speed of rotation, and to some extent by normal variations in pressure, it is very difficult to space sprinklers so that full advantage can be taken of the high degree of uniformity possible with wide spacings under the triangular arrangement. Furthermore, the triangular arrangement is not entirely practical with portable systems.

SUMMARY AND CONCLUSIONS

1 The uniformity of distribution of water from sprinklers varies greatly, depending upon pressure, wind, rotation of sprinkler, spacing, and many other factors.

2 A nearly uniform application is possible with proper sprinkler patterns and with proper spacing of sprinklers.

3 Sprinkler patterns approximately conical, where a maximum application occurs near the sprinkler and decreases gradually to the edge of the area covered, produce a uniform application when sprinklers are not farther apart than 55 or 60 per cent of the diameter covered.

4 For wider spacings a pattern for which the application is uniform for some distance from the sprinkler and then tapers off gradually, is better, but the maximum uniformity obtainable decreases with the spacing for all spacings greater than 50 per cent of the diameter covered.

5 For spacings greater than 50 per cent of the diameter and with equivalent areas covered by each sprinkler, a more uniform application can be obtained with an equilateral triangular arrangement of sprinklers than with a square or rectangular arrangement.

6 A triangular arrangement of sprinklers is more sensitive to spacing than a square or rectangular one. That is, for a given pattern the uniformity of application varies more with a variation in sprinkler spacing.

7 With a portable system and with sprinklers producing desirable patterns, good distributions can be obtained when the line is moved not farther than 50 to 70 per cent of the diameter covered by a sprinkler, and when the spacing of sprinklers along the line is not more than 35 per cent of the diameter covered.

AUTHOR'S ACKNOWLEDGMENT: Credit is given the California Committee on Relationship of Electricity to Agriculture for assistance furnished, and to B. D. Moses for reading the paper at the meeting.

Machines and Jobs

(Continued from page 88)

the machine direct their complaint against individuals who can speak for themselves?

Who really wishes to live in a country that offers no reward for skill, for effort, for ability; no advancement for years of honest work; no opportunity to save? Dwellers in such lands are slaves, not citizens, regardless of what their masters may choose to name them.

However, the idea that we are through with free enterprise and must from now on live a life planned for us by others, is like a disease creeping around the world. It is the duty of all of us to draw upon our experience to prove the benefit of technology. We must defeat the incorrect thinking of honestly intentioned people and forever drive from places of importance those who would substitute a planned economy with its deadly enforcement for our productive system of free enterprise.

One of the most puzzling phases of this conflict of ideas is because both sides seemingly are pointing to the same goal. The fact is they *are* aiming toward the same goal—they differ only in the road which we are asked to take to reach that goal. We know that machines can, have, and will help to take us to that goal. Why discard a fact for a myth? We cannot have more by producing less.

All those who are employed at anything are workers. The man at a lathe, at a plow, at a desk, in a school room, in the doctor's office, in the locomotive or mine—all are workers. Whatever affects the welfare of one will affect all. Some men of high income like to think that men of lower income might suffer and yet they escape. Likewise men of low and modest income think that they would benefit from the elimination of high incomes. Both men think wrongly. Whatever affects one will affect the other. Those who advise either man that he can benefit from the misfortune of the other is either misinformed or deliberately lying. If the personal expenditures of those whom we call rich in this country were completely taken from them and given equally to all others, it would not noticeably increase their income at all. Do those who feel the danger of these few rich wish to exchange these few for one owner of everything —the State?

Perhaps as engineers you have been intrigued by the words "planned economy." Don't forget that engineers plan the behavior of steel, of concrete, of fluids, of engines. Planned economy forces men to drab similarity, and regardless of their desires enforces similar behavior from men and steel and engines alike.

How are we to proceed when we meet the foe of the machine? First, remember it is likely through lack of understanding that a man considers himself a foe of the machine. Secondly, respect his mistaken opinions, he has a right to them, and a right to voice them. Learn why he thinks the way he does; he has reasons. Listen with sympathy and tolerance. Those who have lived in foreign lands have learned to work with people who speak a different language. Interpreters form the connecting link and allow people to work together. The engineer must be the interpreter for technology. He must learn how to show the facts to those who are bewildered and help them to establish in their minds the way which is best. That is our job. People are interested in the work of the engineer and in machines and jobs. Arrange to discuss this subject in terms of your local community, before your clubs, societies, forums, groups of all kinds.

Now what are *you* going to do about it? My family and I are determined to live in these United States of America. I also know you are too smart to move out. When you fight the battle for improved technology, you are fighting the battle of America. You are holding for progress, for production, for more of those things that we all want. When you allow the challenge to the machine to go unanswered, you are lazily allowing destructive forces to gnaw away the foundations of this country. This warning is not intended to scare, but it is a call for action—aggressive, yes, but intelligent, understanding, and tolerant action.

A Sectional Wood Grain Bin

By Roland A. Glaze

MEMBER A.S.A.E.

IN approaching the problem of developing and building the sectional wood grain bin described here, effort was concentrated on eight major points as follows:

1 Floors and walls which would be tight and prevent spoilage from moisture
2 A floor safe from rodent damage
3 A floor of low-cost materials obtainable at any lumber yard
4 A wall section suitable for prefabrication and light enough to permit easy handling
5 The elimination of hoops, bands, and other gadgets commonly used to resist the pressure of the grain
6 A tight sectional roof easily assembled
7 A low-cost wooden ventilator
8 A bin of low cost made from available lumber stocks.

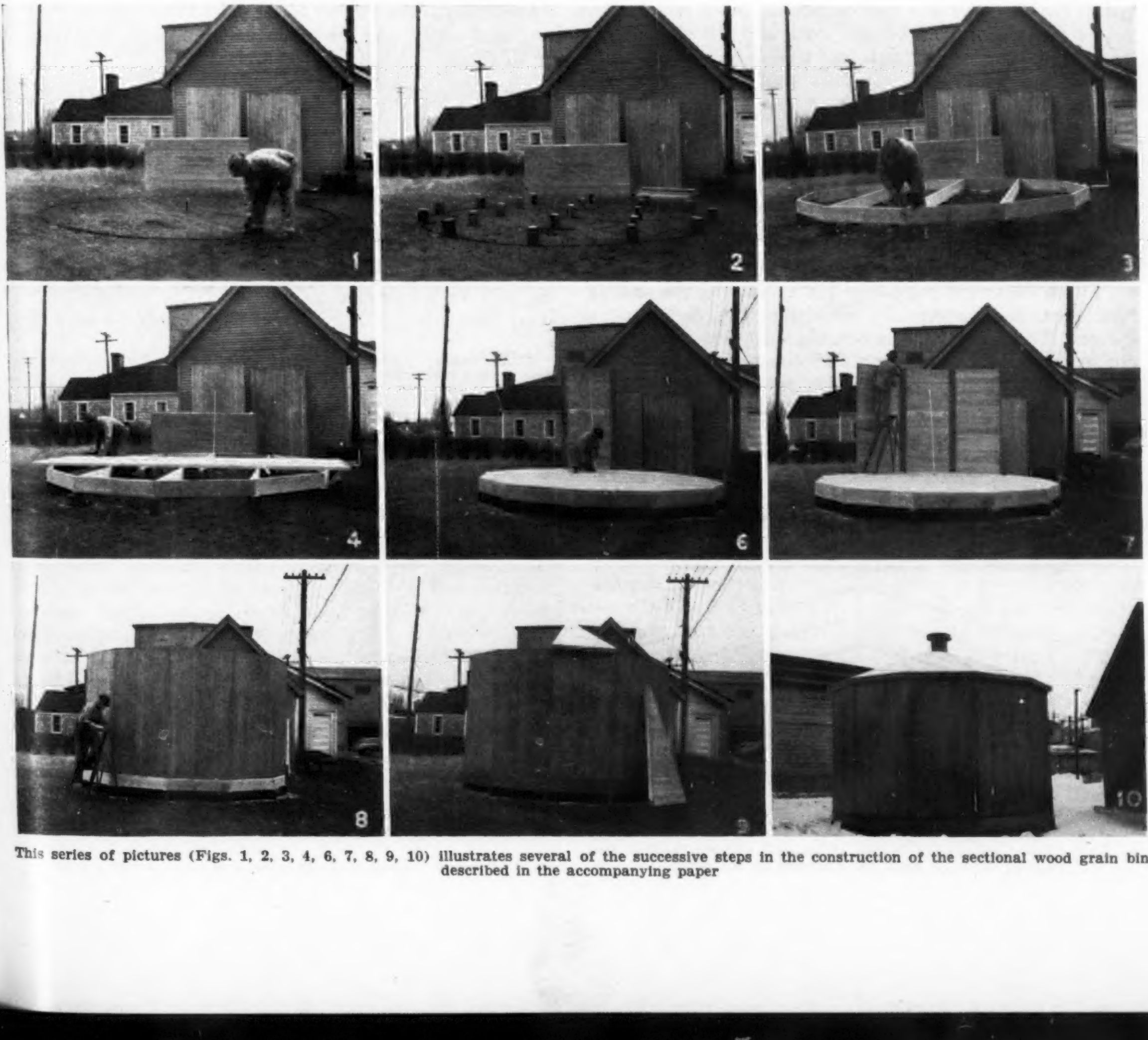
The first step in constructing this grain bin is to drive a stake in the ground at the center of the place where the bin is to be located. The ground does not have to be level. A wire attached to a nail driven in the stake, with a large spike attached to the other end of the wire 7 ft 7¾ in from the center of the stake, provides an easy way of describing a circle 15 ft 3½ in in diameter on the ground (Fig. 1). This is to permit locating the posts or blocks which will serve as the foundation.

After the circle is drawn, it is divided into twelve equal parts. Twelve concrete blocks or posts of cedar or creosoted wood are located at each of these twelve points and nine additional blocks or posts are equally spaced inside of the ring (Fig. 2). These supports carry the floor joists. In localities where high winds are to be encountered, it would be advisable to dig post holes and place cedar posts at each of the twenty-one foundation points. This will permit the building to be securely fastened to the foundation. In most areas, however, this will not be necessary.

After the tops of the blocks have been carefully leveled, twelve 2x8 pieces which have been cut to 47¼ in and beveled to a 75-deg angle on the ends are placed to form the outside joist headers shown in Fig. 3. Three pieces of 2x8 joists are next nailed inside (Fig. 3). The joists are continuous over the supports and no span is greater than 4 ft.

After the headers and joists have been nailed in place, a 2x6, 16-ft floor board is nailed on at the center of the frame. It is then a simple matter to nail the rest of the 2x6, S4S floor stock on each side of the starting piece

A paper presented before the Farm Structures Division at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 3, 1940. Author: Farm structures engineer, Weyerhaeuser Sales Co.



This series of pictures (Figs. 1, 2, 3, 4, 6, 7, 8, 9, 10) illustrates several of the successive steps in the construction of the sectional wood grain bin described in the accompanying paper

(Fig. 4). Lengths required are 16, 12, and 10 ft. Each piece is nailed to the joist and header with two 16d nails. After the floor is nailed, a saw is used to trim the edges.

The next step is to bolt two metal splice plates to one of the prefabricated wall sections. Each of these prefabricated sections is $47\frac{1}{4}$ in wide and made of two thicknesses of 1-in lumber. The outside is 8-in car siding run vertically, and the inside is 1-in D&M, run horizontally. Besides being nailed together, a film of water-resistant casein glue is used to secure additional bond. This makes a solid, weather-tight wall, while the horizontal inside sheathing in combination with the metal plate acts as a continuous structural member to resist the thrusts applied by the load of grain.

Fig. 5 shows a detail of the construction of the joint. I particularly want to call your attention to the metal splice plate. This plate is continuous, running from top to bottom of the section and formed so that a lug fits snugly into saw kerfs on the inside of each panel. This lug is designed to take the full shearing load on each joint. Carriage bolts are used merely to hold the connector strip in place. Note also the segmental anchoring flange at the bottom of each strip. Through a hole in this flange a lag screw is screwed into the floor to anchor the walls securely in place. Fig. 6 shows the first section in place on the floor. The carpenter is using a temporary strip to hold the section upright. It is then an easy matter to continue placing the sections around the floor as shown in Fig. 7.

All the sections are in place in Fig. 8, and bolts are being inserted in the holes to be drawn up from the inside.

The next step in erecting this grain bin is to put on the roof. Fig. 9 shows one roof section in place and another ready. The rafters are of 2x4 stock and the sheathing is 1x6 D&M. Incidentally each roof section weighs 64 lb, and each wall section 134 lb. The first roof section in place is supported at the narrow end by a temporary post. Three bolts in each rafter eliminate the need for any center support after several of the roof sections are in place.

When all of the sections for the entire building have been bolted together, the bin is ready for the ventilator, and for the spout and cover which go with the small circular outlet. Roll roofing is cut in the shape of the roof segments.

Fig. 9 shows the completed bin except for the roofing. Notice the flat-top wooden ventilator with the diagonal louvres. The ventilator is removable and permits filling the bin from the top. The louvre slots are small enough to exclude snow, rain, or birds, and yet permit free passage of air. The bin shown is a 1200-bu bin with 8-ft sides. A bin with 9-ft side sections will hold 1,340 bu; 10-ft, 1,480 bu; 12-ft, 1,620 bu; 14-ft, 1,760 bu; 16-ft, 1,900 bu.

A research project, at present this bin is under test and arrangements for commercial production of the sections are pending.

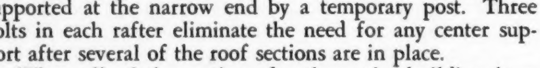


Fig. 5 This shows construction details of the joint between the wall sections of the wood grain bin described by Mr. Glaze

A Home-Made Planimeter

By Howard Matson
MEMBER A.S.A.E.

A SIMPLE planimeter which will give results with less than two per cent error, if manipulated with ordinary care, can be made in a few minutes at a cost of only a few cents.

Fig. 1 shows an instrument adapted from a description by L. M. Dickerson. The instrument should be rigid; the two legs should be approximately in the same plane, and the "hatchet" edge, A, should be kept razor sharp. Drill rod steel 3/16 in in diameter is a satisfactory material, since it can be tempered and is not too difficult to work. The drill rod should be heated to a dull red before bending. Overheating may cause cracking.

The distance AB may be any convenient length. Ten inches is suggested for ordinary use since this simplifies computations to the moving of a decimal point.

The instrument is operated as follows (Fig. 2):

1 By inspection locate the approximate centroid of the area to be planimetered, which is point O. From O draw a line along the long axis of the area to point A on the perimeter.

2 Place the instrument with the point at O and the axis of the instrument approximately perpendicular to the line OA.

3 Hold the planimeter lightly so that both ends will move freely. The hatchet blade should rest upon a sheet of unglazed paper, and the instrument should be held upright at all times.

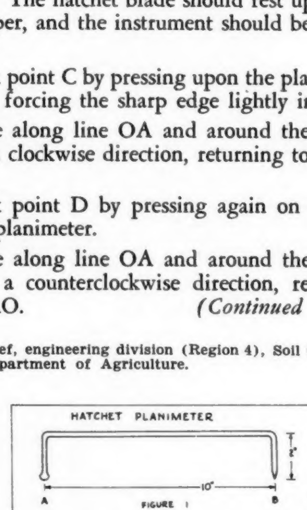
4 Mark point C by pressing upon the planimeter at the hatchet end, forcing the sharp edge lightly into the paper.

5 Trace along line OA and around the perimeter of the area in a clockwise direction, returning to O along line AO.

6 Mark point D by pressing again on the "hatchet" end of the planimeter.

7 Trace along line OA and around the perimeter of the area in a counterclockwise direction, returning to O along line AO. (Continued on page 109)

Author: Chief, engineering division (Region 4), Soil Conservation Service, U. S. Department of Agriculture.



Utilization of Farm Residues

By R. P. Beasley
JUNIOR MEMBER A.S.A.E.

IN THIS paper I will deal with the specific subject of crop residues instead of the more general subject of farm residues. Our great variety of crop residues—cereal straws, corn stalks, etc.,—under present methods of handling, materially reduce the productiveness of our soils.

Organic matter has long been recognized as the key to soil productivity. Under past farming practices little effort was made to maintain this organic matter, and as a result it has been depleted to the point where, in many cases, the productivity has been greatly reduced. At first thought, it may seem that a good way to restore this soil organic matter would be to plow under the crop residues, such as straw and corn stalks. This would, however, be a poor practice, as will be shown.

Soil bacteria, the agents of decomposition, use carbon mainly as a fuel, and nitrogen as a building material for their bodies, in carrying out the process of decomposition. If we plow under some material such as straw or corn stalks, in which the carbon-nitrogen ratio is wide (that is, where there is much more carbon than nitrogen in the material), then the bacteria will be short on building material, and the rate of decomposition will be slow. To speed up this process of decomposition, the bacteria will borrow soluble nitrogen from the soil solutions, where in most cases the supply is already too limited for efficient production. The result is a decrease in crop yield.

But the damage does not stop here; if the bacteria simply borrowed the nitrogen and returned it to the soil solution later on for plant use, the results would not be so bad. This, however, is not done, for during the process of decomposition a large part of this nitrogen is lost through leaching, soil erosion, etc. It is not known just where or how all these losses occur, but that they do occur is shown by an experiment carried out by Dr. W. A. Albrecht[1]. In this experiment it was found that a soil under fallow conditions with single annual plowing, but no mechanical losses or additions, *lost* 115 lb of nitrogen in 14 years from 1918 to 1932. Where a good crop of 2½ tons of red clover was turned under annually, this soil gained 324 lb of nitrogen. Under rye cropping, with the carbonaceous matter all plowed under in the spring and fallowed, the nitrogen *loss* was 640 lb during a similar calendar period but 3 years longer. Where cowpeas replaced this post rye fallow, there was a nitrogen *gain* of 120 lb. These results emphasize the danger of nitrogen depletion by turning under organic residues of a wide carbon-nitrogen ratio, unless sufficient nitrates are added to carry out the process of decomposition.

There has always been the problem of how to handle corn stalks when the corn is husked in the field. It has been common practice to break the stalks in some manner, windrow them, and burn them. This practice is undesirable since burning destroys much plant food which should be returned to the soil. It is, however, difficult to plow stalks under; and even if this could be done easily, the results would not be satisfactory. The stalks cause a loose seedbed, which is undesirable, and in addition the wide carbon-nitrogen ratio is detrimental because of nitrogen depletion in the soil.

A paper presented before the Power and Machinery Division at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 3, 1940. Author: Research instructor in agricultural engineering, University of Missouri.

[1]Albrecht, W. A. Mo. Agr. Exp. Sta. Jrl., Series No. 656.

It was thought that it would prove profitable to remove the stalks from the field, pile them and add the necessary nitrates to facilitate decomposition, and return the material to the field after it had decomposed. The reagents added per ton of dry matter were 67½ lb of 20 per cent ammonium sulphate, 60 lb of finely ground limestone, and 22½ lb of 20 per cent super phosphate. The limestone and phosphate were not necessary to cause decomposition, but were added to insure a well-balanced manure. Other nitrogenous materials may be used in place of ammonium sulphate.

Table 1 shows the cost per acre of piling corn stalks by various methods. Methods I and II are similar in all respects, except that in Method I the standing stalks were broken with a railroad rail, and in Method II they were cut with a stalk-cutter. Breaking with a railroad rail was less expensive, but it was thought that rotting would be facilitated by cutting the stalks into smaller pieces, thus making a more compact pile, so Method II was tried. There has, however, been no difference noted in the degree of rotting of the two piles. Method III is similar to Method I, except that instead of rolling the stalks onto the stack by hand, a sling was prepared to do this work. Fig. 1 shows a sketch of this sling. It was necessary to lay the wires in the trench and pin them so that the stalks could be placed directly on the wires by means of a buck rake. It was possible to pile one acre of stalks at one operation with this arrangement. A team was used to draw up the wires, and the stalks were left in a compact pile about 6 ft in diameter. It was found best to repeat the operation, placing a second roll against the first, making 2 acres of stalks and trash in the completed pile. Piles placed in this manner tend to hold water better and thus facilitate rotting. In Method IV the stalks were pulled by hand, placed on a wagon, taken to the edge of the field, and piled. This method is expensive, but has one advantage over other methods in that it frees the land of corn stubble.

TABLE 1. LABOR AND LABOR COSTS PER ACRE

Operation	Horse labor Hours	Horse labor Cost	Man labor Hours	Man labor Cost	Total Cost
Method I					
Stalks broken with railroad rail	0.6	0.06	0.2	0.04	0.10
Windrowed with dump rake	0.8	0.08	0.4	0.08	0.16
Brought to stack with buck rake	2.0	0.20	1.0	0.20	0.40
Placed on stack by hand			4.0	0.80	0.80
Totals	3.4	0.34	5.6	1.12	1.46
Method II					
Stalks cut with stalk cutter	2.0	0.20	1.0	0.20	0.40
Windrowed with dump rake	0.8	0.08	0.4	0.08	0.16
Brought to stack with buck rake	2.0	0.20	1.0	0.20	0.40
Placed on stack by hand			4.0	0.80	0.80
Totals	4.8	0.48	6.4	1.28	1.76
Method III					
Stalks broken with railroad rail	0.6	0.06	0.2	0.04	0.10
Windrowed with dump rake	0.8	0.08	0.4	0.08	0.16
Brought to stack with buck rake	2.0	0.20	1.0	0.20	0.40
Placed on stack with sling	0.6	0.06	0.6	0.12	0.18
Totals	4.0	0.40	2.2	0.44	0.84
Method IV					
Stalks pulled and loaded on wagon by hand; removed from wagon by sling	6.0	0.60	15.0	3.00	3.60

Material cost per acre $2.40

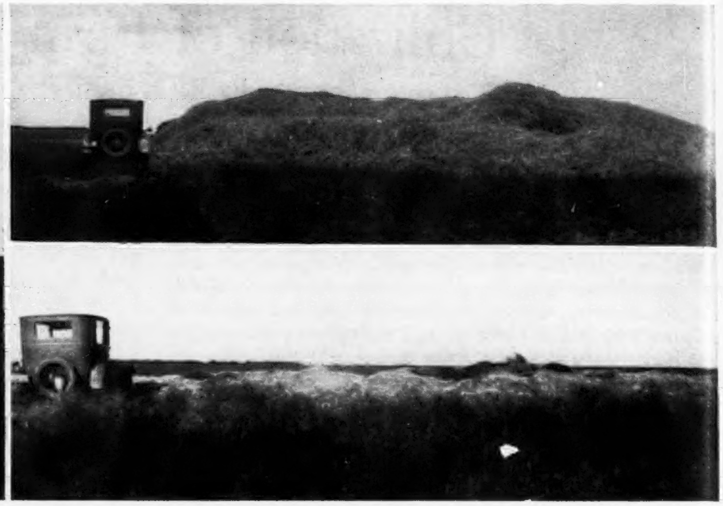


Fig. 2 (Left) Thresher attachment for adding nitrates and other fertilizers to straw at the blower. Fig. 3 (Right) A low strawpile made to catch rain water. Top view shows the pile in July shortly after threshing; bottom view shows the same pile in late November, decomposition having been accelerated by moisture and added nitrates

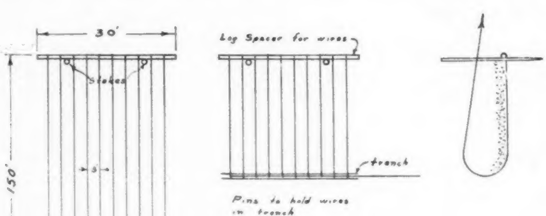


Fig. 1 A sling for piling corn stalks

Before the combine had come into extensive use, there was the problem of how to handle the straw pile following threshing. If there was no reagent added to the straw, it took the pile quite a long time to decay. Quite frequently the straw piles were burned, with the resulting loss of a large amount of plant food. As a means of hastening decay of the straw, an attachment was developed which could be fitted to the thresher and the reagent added to the straw at the blower. Fig. 2 shows a view of the attachment. The straw is blown into a flat pile that will take up water instead of shedding it, thus hastening decay. Fig. 3 shows views of a straw pile that has had the reagent added by this attachment. The first view shows the straw pile in July soon after threshing, and the second view shows the pile in late November. The straw has rotted and is satisfactory to use as a top dressing for wheat.

This attachment has never been used extensively, for with the coming of the combines the problem of handling the straw piles has shifted to one of handling the straw after the combines. If straw is turned under, we have a detrimental effect as a result of the loose seedbed and the shortage of nitrogen in the carbonaceous material. In order to supply this nitrogen for decomposition, an attachment was made for a gang plow which would add a nitrogen reagent to the straw and trash as it was being turned under. It was hoped that by adding the reagent in this manner it would be mixed thoroughly with the straw, and thus cause more rapid decomposition than would be secured if the reagent were broadcast on the straw before plowing. The attachment uses star type of fertilizer distributing units, and is driven from the land wheel of the plow.

This attachment has also been used to add nitrogen to corn stalks as they were being plowed under. With this method of handling, an increase of 8 bu per acre was secured in the corn crop the following year. It is, however, difficult to plow corn stalks under, and when turned under they cause a loose seedbed which is undesirable. It appears that it may be necessary to devise some means of shredding the stalks, following picking, so that they can be plowed under easily and not be detrimental from the standpoint of a loose seedbed. This, however, will not solve the problem of a nitrogen deficiency, and some means of supplying this nitrogen at the time of plowing will be necessary.

There have been attachments developed to broadcast reagents on the material before plowing. These attachments fasten directly onto the tractor, and depend on gravity and vibration of the tractor for distribution.

Experiments are being carried out to determine the best means of handling the straw following combining. The outline of these experiments is given in Table 2. On the first plot, lespedeza is sown in the wheat in the spring, and turned under at the time of plowing, the necessary nitrogen for the decomposition of the straw being supplied by the lespedeza. On the second plot the nitrogen reagent is added to the straw at the time of plowing. On the third plot the straw is turned under with no treatment. On the fourth plot the straw and trash are removed from the field, piled with the reagent added, allowed to rot, and then returned to the plot.

TABLE 2. METHODS OF HANDLING STRAW AFTER COMBINE

Lespedeza as a source of nitrogen	Aero-cyanamid as a source of nitrogen	Straw turned under	All material removed
Sown in wheat in spring and turned under at time of plowing	75 lb per ton of dry matter added at time of plowing	No treatment	Treated with 75 lb of Aero-cyanamid per ton and piled. To be returned to plot when decomposed

This study has not been in progress a sufficient time to secure conclusive results. The purpose of this paper is simply to outline the program of what is being done and to invite criticisms of the study and suggestions for its development.

New Ideas in Rural Electrification Engineering

By M. M. Samuels

IN these troubled times we are fortunate in being engaged in the kind of engineering that could not possibly be used for purposes of destruction, that could only be used for helping to establish peace on earth and good will among men. The things we develop for rural electrification are too small to be used for large-scale destruction. Let us hope that in this world turmoil we will be permitted to continue this engineering of peace. I will confine myself to engineering and attempt to present to you the problems we have solved and, more important, the problems that are not yet solved.

A number of years ago I did some consulting work for an upstate New York utility. Once, while I sat in the office of the superintendent, a ruddy, competent old Scotchman, the telephone rang. He took the receiver off the hook and banged it back again. He jumped up and out of doors and into his flivver. Before I realized it I was sitting alongside him as he drove through the streets ringing his emergency bell, out into the suburbs. He jumped out, climbed a pole, came down, looked at his watch, hardly able to draw his breath, and said: "I got it within half a minute." When I inquired what it was all about, he replied, "It is this chicken farmer. My contract reads that if I do not restore service within so many minutes, I have to give him new eggs. Well, I just saved my company 10,000 eggs, within half a minute."

A paper presented before the Rural Electric Division at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 5, 1940. Abridged. Author: Acting chief, technical standards division (formerly chief research engineer), Rural Electrification Administration, U. S. Department of Agriculture.

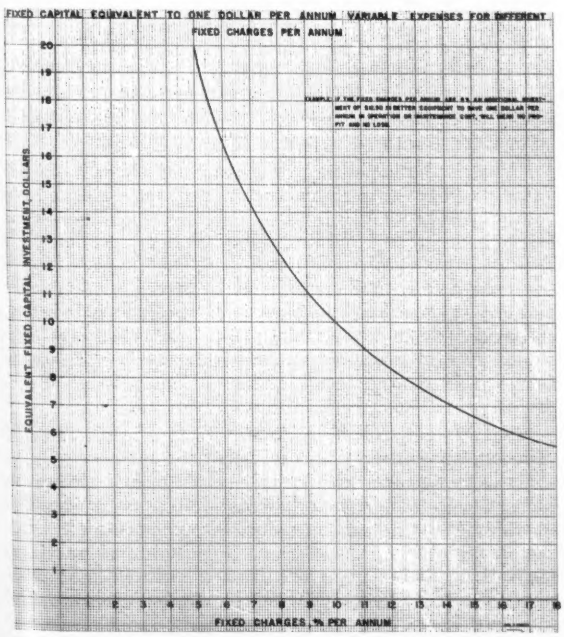


Fig. 1 Justifiable fixed capital investment is that which saves more variable charges than it costs in annual fixed charges. In choosing between alternative pieces or combinations of engineered equipment to do the same job, the best from an investment standpoint is that which shows the greatest remainder when annual charges on the investment represented are subtracted from the savings made in variable charges

And here is the other side of the picture. We have a young engineer from Florida with a good sense of humor. He was engrossed in the computation of short circuit currents on one of the REA systems. When I asked him how he was making out, he said, "Terrible, down here at the far end of this line there are not enough amperes to blow your nose, to say nothing of blowing a fuse."

Here we have the main engineering problem in a nut shell. On one hand we deal with loads that call for a high degree of service reliability, and on the other we deal with small currents for which, as yet, there are no adequate protective devices, at least within the available means. This is the sum and substance of all engineering problems of rural electrification: to provide service of a high degree of reliability at low cost. We realize that it is like saying that we are between the devil and the deep blue sea. But we are optimists, we are plugging along trying to solve the problems in the usual engineering manner, by tackling them one at a time.

ANALYZING FARM SERVICE REQUIREMENTS

A farmer represents the combination of a residential, commercial, and industrial customer in one, using the utility vernacular of classifying customers, and he requires the best service of the three classes combined. We searched the literature and talked to many competent experts, trying to find out what outages of various duration would mean to the various electrical applications on the farm. While we found a considerable amount of discussion, we found no definite crystallization that could serve as a foundation for the design of line and power supply. So we started from scratch, in primary grade engineering manner.

Stanley J. Otis of our research engineering staff prepared a rather complete list of several hundred electrical applications on the farm. For each of these we want to know what $\frac{1}{2}$ min of service interruption will mean, what 5 min will mean, and what a week will mean. We sent the score card out to six outstanding agricultural engineers, asking them to mark for each duration, for each operation, one of six marks, as follows: A, slight inconvenience; B, inconvenience; C, serious inconvenience; D, slight damage; E, serious damage, and F, destruction of product. We asked them to confine themselves, for the moment, to cases that appeared to them to be self-evident.

Thus we hope to establish many of the questions as definitely answered, and then we hope to do a little research, with your cooperation, to find answers to the other questions. Then we will know that, in certain cases, we can get along with a cheap installation and that, in other cases, we may have to decide that unless we can provide two sources of supply we had better not provide any service at all. Until we have that, we will have no solid foundation for the design of rural circuits.

What is a rural power system? A power source, be it a small power house or a sub-station; a primary circuit, generally about 6900 volts; a little transformer, a little lightning arrester, a little primary fuse, a secondary to the house, a meter and a service entrance, and now and then a sectionalizing device. We have over 600 substations where we buy power from electric utilities, mostly privately owned but some publicly owned. We found ourselves called upon to render service to numerous establishments of importance

to national defense, and we found that many of our sources of power are not adequate for this important purpose. We took many steps to provide remedies, of which I will recite only one. We developed small mobile power plants on trailers, each a complete power house with two diesel generating units, switch gear, and transformer. We can move them from place to place as needed to provide power. We hope to have enough of them throughout the country soon so that each REA project can be reached by one in a very short time. Every city that operates a network system should have and probably will be forced to have a number of such units to bring power quickly to hospitals and similar places, when the main power supply fails. As time goes on you will hear more and more about mobile and floating plants used for national defense.

The lack of adequate data on the demand diversity of various applications on the farm makes circuit design difficult. We hope to have soon a low-price demand meter which will make this study possible. After an accumulation of data with the aid of hundreds of such meters, great economy in circuit design may be anticipated. In the meantime, we already have enough data that seem to indicate that the $1\frac{1}{2}$-kva transformer is not the best size for rural loads, that in many cases 1 kva is ample. There is no 1-kva transformer on the market as yet, but conversations with manufacturers indicate that there soon will be.

What is there to a little transformer? There is more to it than anyone thinks. I have handled many large transformers, as large as they make them, and I had practically no headaches from them at all. The little transformers give us no end of headaches. First of all, our consumers are so far apart that only seldom can we have secondary distribution; in most cases we have to have a separate transformer for each consumer, and, as I told you before, we don't know what size to use. This is a new problem that does not exist in urban distribution at all.

VARIABLE AND FIXED CHARGES AS INFLUENCES ON CHOICE OF EQUIPMENT

Now, take the question of balancing variable charges against fixed charges. The term "fixed charges" does not exist in the uniform classification of accounts for electric utilities, but the term "operating expenses" does exist, so you cannot add fixed charges and operating expenses to get the total. I am using the Federal Power Commission definitions. Fixed charges mean interest and amortization of debt, discount and expenses, property taxes and property insurance. Variable charges represent the difference between the total charges and the fixed charges. The accompanying chart (Fig. 1) shows a line of demarkation between fixed charges and variable charges. The lower your fixed charges, the more you can spend on better equipment to save a dollar a year in variable charges. This is important for any business, but more important for public business. If you are below the line, you show a profit; if you are above the line, you show a loss. Now look at the other chart (Fig. 2). The lower your fixed charges and the higher your energy cost, the more you can afford to spend on a transformer having a lower core loss. Our projects have a relatively low fixed charge and a relatively high energy cost. We can afford to spend quite a little on first cost to get low core losses. Private utilities have high fixed charges and low energy costs. They can afford to spend little to save core losses. Many industries, too, have low fixed charges and high energy cost. There should be two designs of transformer, one for electric utilities, with low first cost, even though the core losses are high, and another

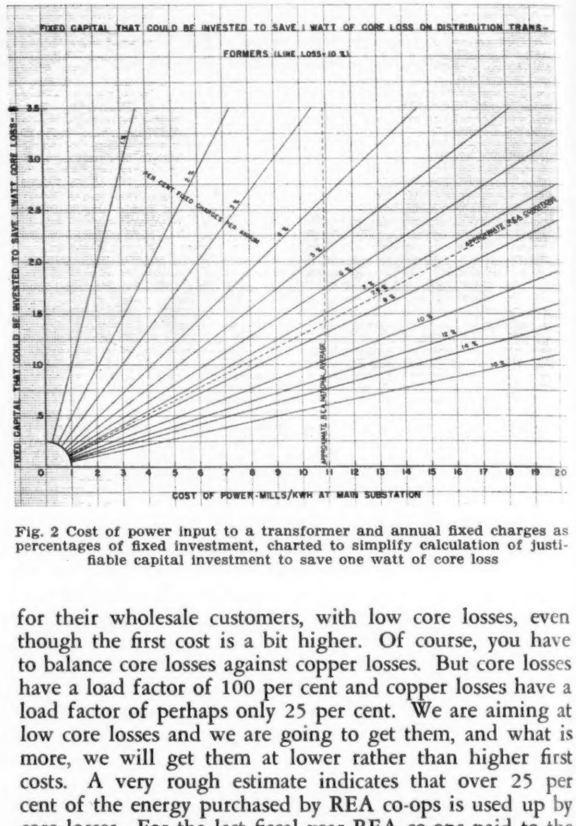


Fig. 2 Cost of power input to a transformer and annual fixed charges as percentages of fixed investment, charted to simplify calculation of justifiable capital investment to save one watt of core loss

for their wholesale customers, with low core losses, even though the first cost is a bit higher. Of course, you have to balance core losses against copper losses. But core losses have a load factor of 100 per cent and copper losses have a load factor of perhaps only 25 per cent. We are aiming at low core losses and we are going to get them, and what is more, we will get them at lower rather than higher first costs. A very rough estimate indicates that over 25 per cent of the energy purchased by REA co-ops is used up by core losses. For the last fiscal year REA co-ops paid to the electric utilities \$4,426,642 for power, of which \$1,106,660 were for core losses.

One new 1-kva transformer is not quite finished but the core losses are less than 10 watts with a regulation of $3\frac{3}{4}$ per cent and it will not cost much over \$25.00. The lowest price we have on a $1\frac{1}{2}$-kva transformer is \$35.34 and the lowest core losses we get are 21 watts, the average price being \$39.73 with 24-watt core losses.

What is the impedance of a grounded circuit? No one knows, no one can possibly know. And yet we have been doing some good guessing and have developed a method for computing the coordination of overcurrent protective devices, much simpler and much more competent than anyone used before. We can now make a coordination study in a day that used to take a week or two, and it is better. I consider Bruce O. Watkins, who is in charge of this work in REA, as the outstanding authority in this specific field in the country. A set of instructions that he is now preparing will soon be available to everyone.

Certain tests made by engineers engaged in the study of telephone coordination have indicated the presence of relatively large amounts of harmonic currents and voltages on REA systems. In one case they found 10 amps at 60 cycles and 13 amps at 300 cycles. Does the presence of the harmonics mean increased losses or impairment of operating efficiency on REA systems? Will a standard watt-hour meter record harmonic power? Do the harmonics increase or decrease the losses in electric motors? What about fluorescent lamps? Will harmonics effect their operation? This calls for new investigations, new headaches, but also, let us hope, new thrills. Once you know that a problem exists, you have to try to solve it. We hope to begin soon.

NEW DEVELOPMENTS

Carrier Signal. It was found that with the long distances covered by the various projects, it frequently took a long time, sometimes a day or more, before it was known at the cooperative headquarters that a section of line was out of service. Means had to be found to notify the cooperative headquarters at once of such occurrences. Discussions with various manufacturers revealed that they had nothing at all to offer. Two young engineers of REA were put to work, and they perfected a device which has now been found to work satisfactorily and which will probably cost only about $60 per unit. It is now being placed in production and it is hoped that within a few months will be available to all cooperatives of REA and also to utilities. As soon as a section of line is out, it will be recorded automatically on a tape at project headquarters, sub-station, or power house, giving the location of the outage and the time it occurred. A similar record will be made automatically when service is restored.

Meters. The progress made in meter development through the incentive of C. A. Winder of REA is now known generally. The cyclometer type meter now made by all meter manufacturers, makes it possible for farmers to read their own meters, saving great sums of money in meter reading. It also has the educational value of making the farmer understand and see how much energy he consumes. A new manufacturer entered into the meter business and reduced the cost of the meter by over $2.00, without reducing the accuracy.

Services. After line costs had been reduced considerably, it was found that REA cooperatives could now afford to furnish distribution cabinets to the farmers as part of the line construction costs, making it unnecessary for them to charge it to the cost of house wiring. But there was no suitable or satisfactory arrangement on the market for this purpose. It was decided that it was necessary to eliminate fuses in the farm home, to make it unnecessary for farmers to keep a stock of fuses and to blow a number of fuses every time there is a short circuit, or to telephone the headquarters, which may be fifty miles away, to send someone out to replace a fuse. The new development has no fuses. It only uses circuit breakers. These circuit breakers are not new; they have been used for many years. But the new device combines the meter and the service box as a unit. This is a new feature and makes it possible for the farmer to have a better combined meter and service box arrangement than is now in existence in many of the most expensive homes, and he will get it for no more money than the previous junky arrangements.

Milk Coolers. It was found that there was no cooler on the market for the farmer who has only one can of milk. The smallest cooler available was for two cans of milk, and cost $150 or so. A manufacturer is now on the market with such a cooler for one can of milk, which will cost only around $80.00.

Ground Testing Meters. It is of great importance on all electric systems to maintain good ground connections, to prevent danger to life and property. In order to make sure that ground connections are intact, it is necessary to test them periodically. Until a short time ago the instrument most commonly used for such tests was imported from a foreign country and cost about $350.00. This was altogether out of the question for the hundreds of cooperatives. An American meter was in existence and cost about $95.00. Through the efforts of REA, this meter was modified somewhat by the inventor, and many REA cooperatives are now in possession of such a meter, for which they paid only $28.00. However, in some respects this meter was not satisfactory because in order to read it, it was necessary to use an ear phone in combination with the dial of the meter. A young engineer of REA therefore developed a new meter which does not require any ear phone. The meter is now going into production and will be on the market at $27.50, but REA cooperatives will pay 10 per cent less because the inventor does not collect royalties from these cooperatives.

Radio Interference. Everyone who has a radio knows that unpleasant noises frequently come in through the loud speaker. Many of these noises are caused by the electric system, but others are not. Every cooperative receives complaints about noises, and it is sometimes a difficult matter to determine whether the REA system or other sources are responsible for the noises. If the system causes the noise, it is necessary to establish exactly the location of the source of the noise and to remedy it. Stimulation by REA research engineers induced a manufacturer to develop an instrument for establishing the cause and source of radio noises.

Telephone Coordination. Electric power lines and electric generating and transforming equipment frequently cause noises in telephone systems, sometimes making it almost impossible to carry on a conversation. Disputes between power companies and telephone companies have been going on since telephone systems and power systems existed alongside of each other. It was natural that similar disputes would arise in REA. The study and elimination of such noises, or, as they are known, inductive interferences, calls for the highest technical skill and specially designed and built instruments. The Bell Telephone Laboratories are the only institution in possession of such instruments, and, besides, of twenty years of experience in this work. Cooperation was therefore established with that institution and three of the most brilliant young engineers of REA were assigned to this work. Many problems have already been solved by this cooperation. Many disputes have been settled, and some law suits have been won by REA cooperatives in connection with this work.

Ground Fitting. For the purpose of testing the ground, it is now necessary to dig up close to the pole and disconnect a fitting underground. This requires a considerable amount of time, and there is always the possibility of forgetting to reconnect. An REA engineer invented a new fitting which is mounted on the pole, and all that is necessary for testing the ground resistance is to insert into this fitting a key which is attached to the meter. This fitting is now being placed on the market at a price of forty-five cents. It will save a great deal of time and will also add considerably to safety.

Limited Service Equipment. While equipment was available on the market to serve a farmer who takes a considerable amount of electric service, there was no equipment sufficiently low in price to be able to render service to a poor farmer or sharecropper. R. B. Craig, REA deputy administrator, started the movement to induce the manufacturers to produce such equipment. Mr. Winder took up the work and finally succeeded in securing such equipment which is low enough in price so that it is now possible to offer a limited amount of electric service at such a low price that the sharecropper can afford it.

INDUSTRIAL LOADS IN RURAL AREAS

It was known that for some years past Germany had been making rapid strides in rural electrification. The avowed purpose of the extension of service to rural areas was the provision of lights and power for feed grinders and other small farm machinery. However, soon after the

farmer was provided with electric service, sealed crates of machinery arrived at his farm and he was told that they contained machinery for the manufacture of toys. Soon, the officials said, he would receive instructions for their use and the products would help supplement his income. With the start of the war on Poland came the unpacking of the machines and instructions for their use. The toys turned out to be parts for guns, airplanes, and munitions. Each farm made some small part, and with the aid of a good network of roads these were easily and swiftly carried to assembly plants and there assembled into completed armaments or other necessities of war.

The importance of decentralization of key industries for our own defense program is now so obvious that it need hardly be argued. The fact that our present setup is extremely vulnerable to attack has been recognized for some time. A centralized industrial system with complete manufacturing and assembly units housed under one roof and hundreds or even thousands of such units bunched together at one point is not only easy to bomb out of existence, but is also an ideal setup for the saboteur. He need only cripple one source of power to put out of operation an entire city with its enormous production facilities. Obviously, the only cure for this evil is the scattering of the production process over so large an area that it would be impossible to put out of action at any one time or place enough of the facilities to seriously curtail the industrial output.

In the fall of 1938 applications for power for industrial uses began coming in to various REA system offices in considerable numbers and were referred by them to headquarters. The importance of industries in rural areas was finally recognized and the proper facilities set up in REA to handle these applications. A definite procedure for securing and analyzing the necessary data and for making the engineering and rate computations has been set up and applications for industrial power are now pouring in.

ADVANTAGES AND POSSIBILITIES OF DECENTRALIZING RURAL INDUSTRIES

In critical times such as these, the problem of national defense is of course uppermost in everyone's mind, and the decentralization of industry is looked at mainly from the point of view of its advantages to defense. This has tended to overshadow the social implications of the problem.

It has been suggested by some people that farming is only a part-time occupation and that this is the reason for the low income of the farmer. The provision of additional "sidelines" by which the farmer can supplement his income, should therefore tend to raise the national farm income. No better way can be found than by the decentralization of industry. The part that REA is now playing in this step was shown in a recent report of industrial and commercial loads connected on REA lines as of January 1940. This report showed that in a short space of time over 3500 such services had been connected, with a total load of over 57,000 kva. In this report only loads of 5 kva or larger were taken into account. These represented 113 different types of industrial activities in rural communities. They included such widely differing industries and power uses as irrigation, cotton gins, airplane beacons and landing fields, schools, municipal water supply systems, cheese factories, feed grinders, sawmills, lumber yards and planing mills, coal mines, oil well pumps and oil pipe lines, various mineral mines, brick and tile factories, stone quarries, machine shops, munitions plants, cement factories, filling stations, amusement halls, hotels, and motion picture theatres. In addition to these more common usages of power, they also included such unusual applications as fur farms, lighthouses, railroad roundhouses, cranberry marshes, bedspread factories, beverage bottling works, fish hatcheries, prison farms, CCC camps, and many federal, state, and local governmental services. All this was accomplished without any stimulation by REA and without lending government money. It is an outstanding example of the indirect stimulation of individual initiative by an existing government activity.

Since last January numerous additional loads have been connected at the rate of about 1,000 kva per month. Among these have been many important to our national defense, such as a group of mercury mines in Arkansas, many army camps, and additional CAA facilities. Early in 1941 a new report of industrial activity on REA lines will be published.

COOPERATION WITH UNIVERSITIES AND COLLEGES

Since the Rural Electrification Administration has virtually no laboratory facilities and a limited staff, no extensive research can be carried out in studying the electrical problems of agriculture or in making tests so necessary to safe, successful rural system operation. Limited use can be made of the facilities of the National Bureau of Standards, but this is confined to generalized tests of system design, construction materials, and operating supplies.

Early in August 1940, in anticipation of future needs, a committee of six staff members was set up by REA to supervise a survey of research in the field of rural electrification by state universities and land-grant colleges. Of 68 institutions in the first survey list, reports have been received from forty-nine. These survey reports, as submitted by our field representative, present an accurate picture of the activity of any institution in the field of rural electrification.

In progress at the present time is a composite index file which will list, alphabetically by subjects, all schools engaged in study of any phase of rural electrification or related fields. Although less than one quarter of the schools included in the first survey have been so catalogued, this directory has already revealed an enormous volume of extremely valuable information.

As an indication of the ultimate value of this survey, let us look briefly at some of this information chosen at random from this partially completed file. Certain routine tests are essential to safe, successful operation. Most REA financed rural systems are too small to maintain elaborate test equipment and commercial test laboratories are located principally in large eastern cities. It was, therefore, gratifying to us to learn from the tabulations made thus far that over two-thirds of the institutions can calibrate rotating standards used in testing watthour meters; over one-half of the schools can make breakdown tests of linemen's rubber gloves; almost one-half of the schools have high voltages of 50,000 volts or over which can be used in testing insulators, insulating oils, and hot-line tools; and in one case, a surge generator, an extremely rare piece of equipment supplying well over two million volts, is available. And these are only a few examples. Instrument transformers can be calibrated, equipment is available for locating radio interference sources, ground resistance measurements can be made, and so on through a long list of services.

This survey is providing in one source, data on information available, work in progress, and a key to facilities, which would be useful in further studies along any given line. When it is completed, all the information will be made available to your society.

As a motto for all of us, in fact for all engineers, I would suggest an expression used by Justice Frankfurter: "To translate knowledge into action and to gain further knowledge by action."

Tests of Tillage Tools

III. Effect of Shape on the Draft of 14-Inch Moldboard Plow Bottoms

By I. F. Reed

MEMBER A.S.A.E.

THE U.S.D.A. Farm Tillage Machinery Laboratory, the equipment and procedure for making studies of tillage tools, and effects of factors external to the plow bottoms on the reactions of 14-in moldboard plows have been discussed in earlier papers[1,2,3]. This paper is partially limited to the data showing the effects of certain shape and design factors on the draft and operation of 14-in tractor plow bottoms. Soil conditions, attachments, width and depth settings, height of hitch, and other controllable factors external to the bottom were kept as nearly constant as possible for each series of tests. All symbols will be as used and defined in the last publication on this subject[3] by the Bureau of Agricultural Chemistry and Engineering. It will be noted that some of the plow bottoms referred to in that article are used in this study. The reader is cautioned, however, that soil condition must be considered when comparing bottoms. Thus, as shown later in this paper, it may not be possible to interpolate the effects of other speeds, etc., from previous articles and have them hold good for the bottoms and conditions used in this study.

The effect of shape on the reactions and operation of moldboard plows can be shown best by presenting (1) the effects of the shape changes covered by the major classifications, that is, sod, general-purpose, and stubble bottoms, and (2) the effects of shape variations within the general-purpose group. Bottoms classified as speed bottoms are left in the general-purpose group. The 16 bottoms used or discussed in this paper are described in Table 1.

Information given in Table 1 classifies the bottoms and describes them for general discussion but does not enable accounting for variations in shape and reactions of bottoms within the same classification. For example, the classification indicates that bottoms 2, 12, 20, 34, and others are similar, yet in tests one of them will have consistently higher draft than the others. The contour drawings of the bottoms shown in Figs. 1 and 2 were made by measuring the distances from a vertical plane at 45 deg to the landside of each bottom and plotting the data for each inch in height above the cutting edge of the share as projections on a plane parallel to the normal furrow bottom. Thus they give the projections of the intersections of the face of the moldboards with a series of horizontal planes spaced one inch apart. These lines of intersections, referred to hereafter as contours, are numbered from the cutting edge upward so that the number on the contour indicates its distance above the cutting edge.

Effect of Type of Bottom on Draft. Five bottoms representing major classifications of plow bottom shapes were used in three soil types to determine the effect of these major shapes on the draft of 14-in moldboard plow bottoms. The bottoms chosen were No. 40, sod or prairie breaker; No. 2, conventional general-purpose; No. 30, general-purpose with simplified share and radial mold; No. 19, stubble or sandy land, and No. 21, slat-curvature similar to stubble. These bottoms are shown in Fig. 3 and their contours in Fig. 1. They were used at 3.6 and 4.8 mph in Norfolk sand under two conditions, Davidson loam under three conditions, and Decatur clay under three conditions.

Tests in each soil condition were replicated two to four times. The average data for the replications are given in Table 2 and are shown graphically in Figs. 4 and 5. The analyses of the three soils used are shown in Table 3. Soil conditions for these tests are given in Table 4. These test data show that the draft of the sod bottom was high at both speeds for all soil conditions in the Norfolk sand and Davidson loam.

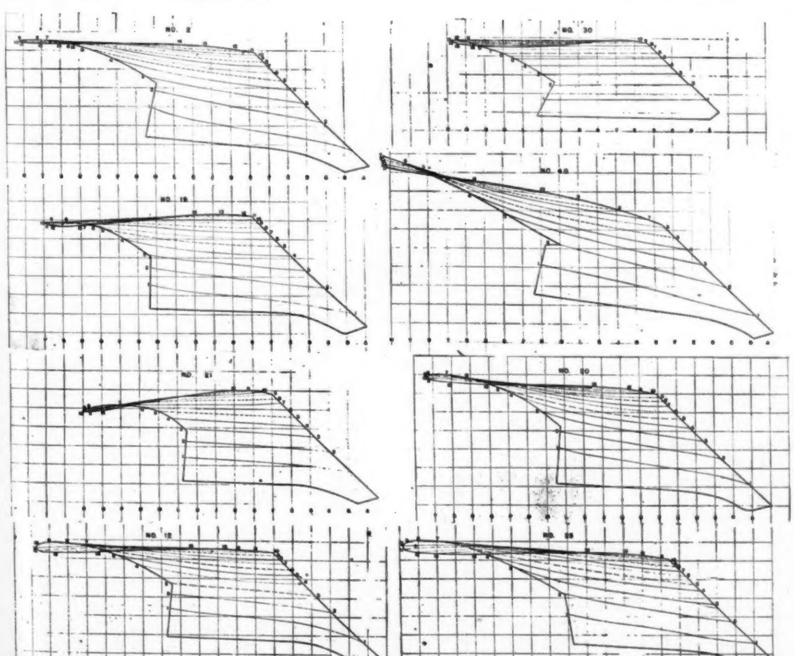


Fig. 1 Drawings of the contours of plow bottom Nos. 2, 12, 20, and 25, general-purpose; No. 30, general-purpose with simplified share; No. 40, sod; No. 19, stubble; and No. 21, slat. Each major square represents 2 in in either direction

A paper presented before the Power and Machinery Division at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 4, 1940. Author: Associate agricultural engineer, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture.

[1]Randolph, J. W. and Reed, I. F. The farm tillage machinery laboratory. Agri. Eng. Vol. 16, No. 6 (June 1935).

[2]Reed, I. F. Tests of tillage tools. I. Equipment and procedure for moldboard plows. Agri. Eng. Vol. 18, No. 3 (March 1937).

[3]Randolph, J. W. and Reed, I. F. Tests of tillage tools. II. Effects of several factors on the reactions of fourteen-inch moldboard plows. Agri. Eng. Vol. 19, No. 1 (January 1938).

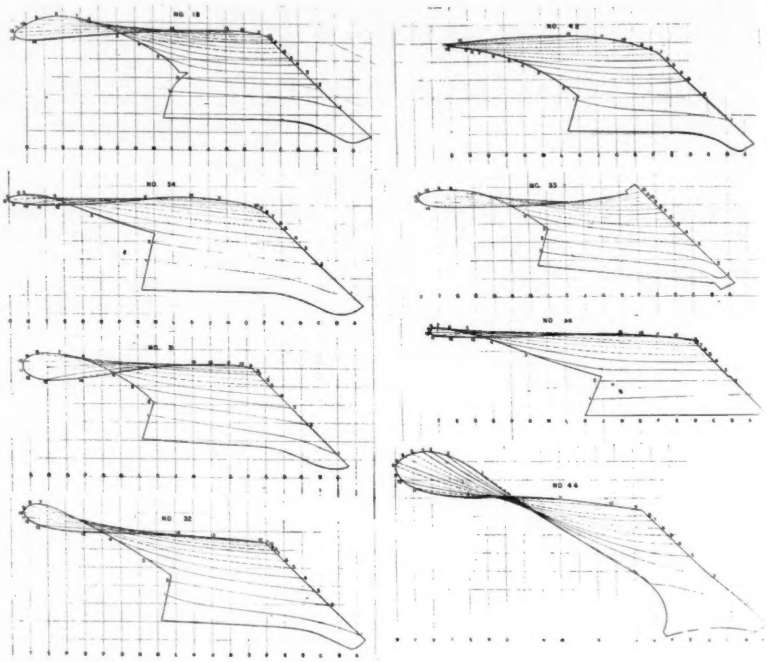


Fig. 2 Contours of plow bottom Nos. 34, 31, and 32, general-purpose; Nos. 33 and 38, general-purpose with simplified share arrangements; No. 18, general-purpose for speed; No. 42, blackland; and No. 44, commonly called English type bottom

Its draft was near the average of that for the other bottoms for conditions 2 and 3 in the Decatur clay and was distinctly low for condition 1. Table 3 shows the apparent specific gravity of the 2 to 6-in depth range for condition 1 to be slightly higher than for conditions 2 and 3. The soil plowed up quite mellow for the other two conditions but was stiff for No. 1. This is shown by the extremely high draft of all bottoms for this condition. The variations in draft between bottoms 30, 19, 2, and 21 were slight and more or less inconsistent, that is, sometimes one and sometimes another would be low for the tests in Norfolk sand, Davidson loam, and conditions 2 and 3 for the Decatur clay. This does not hold true, however, for condition 1 in the Decatur clay. Warping this stiff furrow slice becomes a problem and is reflected in higher draft for bottoms 19 and 21 which have most abrupt curvature. It may seem that the curvature of bottom No. 30 (Fig. 1) is almost as abrupt as that for Nos. 19 and 21, but the method

TABLE 1. BOTTOMS USED IN THIS STUDY

Bottom No.	Type and general classification
2	General-purpose. Near an average of this type
12	General-purpose. Near an average of this type
18	General-purpose. Designed for higher speeds
19	Stubble or sandy land. Short, abrupt moldboard
20	General-purpose. Similar to Nos. 2 and 12
21	Slat. With curvature similar to No. 19
25	General-purpose. Similar to Nos. 2 and 12
30	General-purpose. Simplified share. Moldboard section of cylinder
31	General-purpose. Similar to No. 18. Not quite so extreme.
32	General-purpose.
33	General-purpose. Simplified share. Moldboard for speed to 5 mph
34	General-purpose. Similar to Nos. 2 and 12
38	General-purpose. Simplified share. Moldboard similar to No. 25
40	Sod or prairie breaker.
42	Blackland. Designed for heavy, waxy soils
44	Often referred to as English type.

of approach of the cutting edge and moldboard to the furrow slice is different. No. 30 starts the furrow slice turning from the cutting edge, whereas with the other two bottoms the point of the share tends to lift the furrow slice so that it forms a column ahead of the moldboard. The abrupt angle between the moldboard and this column and the adhesion of the soil to the moldboard cause the furrow

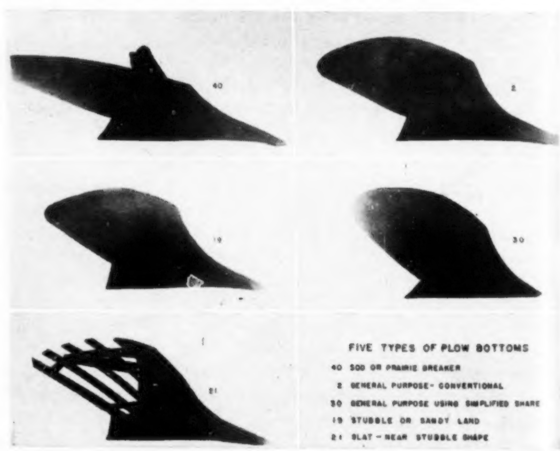
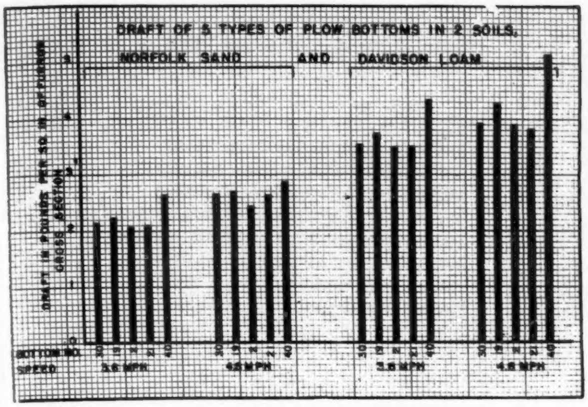


Fig. 3 Typical examples of general bottom types tested

TABLE 2. DRAFT OF FIVE TYPES OF BOTTOMS AT TWO SPEEDS IN THREE TYPES OF SOIL
(Data are given for two or three conditions for each soil)

Bottom No. / Condition No.	30		9		2		21		40	
	3.6 mph	4.8 mph	3.6 mph	4.8 mph	3.6 mph	4.8 mph	3.6 mph	4.8 mph	3.6 mph	4.8 mph
Norfolk sand										
1	2.16*	2.56	2.26	2.64	2.00	2.32	2.00	2.38	2.57	2.63
2	2.19	2.75	2.20	2.76	2.14	2.50	2.19	2.86	2.69	3.09
Average	2.18	2.66	2.23	2.70	2.07	2.41	2.09	2.62	2.63	2.86
Davidson loam										
1	4.22	4.34	4.77	5.56	4.65	5.38	4.59	4.84	5.69	7.70
2	2.90	3.26	2.98	3.16	2.66	2.79	2.62	2.72	3.19	3.41
3	3.49	4.12	3.44	4.02	3.15	3.46	3.28	3.88	4.14	4.36
Average	3.54	3.91	3.73	4.25	3.49	3.88	3.50	3.81	4.34	5.16
Decatur clay										
1	7.51	9.20	10.84	13.29	8.84	9.50	8.88	11.71	6.94	8.91
2	6.32	6.92	7.42	8.45	6.85	7.03	6.36	6.66	8.58	9.10
3	3.87	4.35	4.21	4.52	4.70	5.13	4.10	4.74	4.91	4.85
Average	5.90	6.82	7.49	8.75	6.80	7.22	6.45	7.70	6.81	7.62

NOTE: Each value is the average for at least two tests in that soil condition. All draft figures are in pounds per square inch of furrow slice cross section.



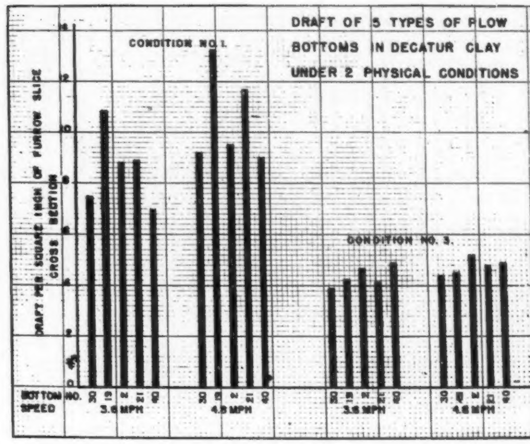


Fig. 4 (Left) Influence of speed on draft in two different soils. Fig. 5 (Right) Influence of speed on draft in one soil under two physical conditions

slice to exert a high force against the moldboard rather than turn smoothly with it. The shape of bottom No. 30 does not allow this column to form. The soil column is formed for bottoms No. 2 and No. 40, but the slower curvature of the upper part of the moldboards allows it to slide along the surface.

Apparently two factors tend to cause the draft of the sod bottom No. 40 to be higher than the others in the mellow soil conditions. They are (1) the large area of moldboard which contacts the soil and (2) the under edge of the wing of the moldboard being low causes the soil to be carried or pushed farther than by the other bottoms. This produces a wide, open furrow. Note in Fig. 1 that the 4-in contour intersects the edge of the moldboard 7 in beyond the edge of the share. This measurement ranges from 1 to 3 in for the remainder of the bottoms in this group. Another factor on which it would be difficult to obtain data, but which should be given consideration, is that most bottoms, except breaker bottoms, are designed for working 5 to 7 in deep. Since the breaker bottoms are normally operated $2\frac{1}{2}$ to 4 in deep, this bottom was working outside of its normal range.

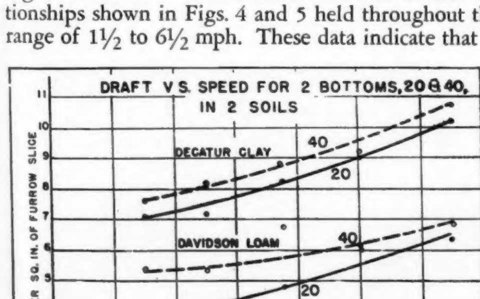
Because it is generally thought that the slow-turn sod bottoms should have lower draft than either stubble or general-purpose bottoms, the tests shown in Table 5 and Fig. 6 were made to determine whether or not the relationships shown in Figs. 4 and 5 held throughout the speed range of $1\frac{1}{2}$ to $6\frac{1}{2}$ mph. These data indicate that they do. The speed curves (Fig. 6) show that the draft of the sod bottom (No. 40) is higher than the general-purpose bottom (No. 20) for the conditions used in both the Decatur clay and the Davidson loam. In the former type of soil the difference is about the same over the entire speed range, whereas in the latter type the difference in the draft of the two bottoms becomes less with increasing speed. This again seems to be explained by the low portion on the wing of the moldboard of the sod bottom. At low speeds the general-purpose bottom begins to release the soil almost even with the edge of the share, but the low wing on the sod bottom pushes the soil 4 to 5 in farther. At higher speed or in heavier soils this effect is less evident as the soil tends to follow up the moldboards instead of being merely pushed over.

TABLE 3. ANALYSIS OF SOILS

Soil	Sand per cent	Silt per cent	Clay per cent	Organic matter per cent	Silica Sesquioxide ratio SiO_2/R_2O_3	pH
Norfolk sand	89.2	2.00	8.8	0.90	1.86	5.34
Davidson loam[a]	72.8	3.38	23.82	1.18	1.43	5.32
Decatur clay	28.1	31.3	40.6	0.98	1.67	5.75

[a]This soil is actually a loamy sand but is referred to as loam for convenience in presentation.

Effect of Shape Factors Within a Classification. The discussion of the effects of types of bottoms on draft shows that variations in shape which cause bottoms to be placed in these broad arbitrary classifications definitely and characteristically affect draft in different soils and soil conditions.



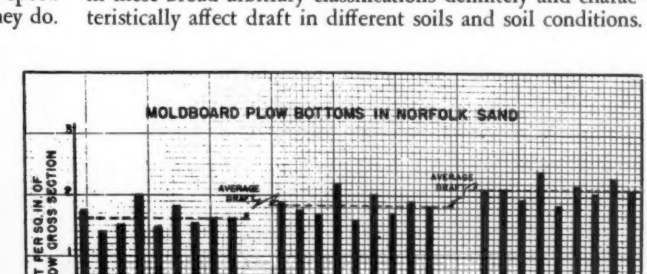
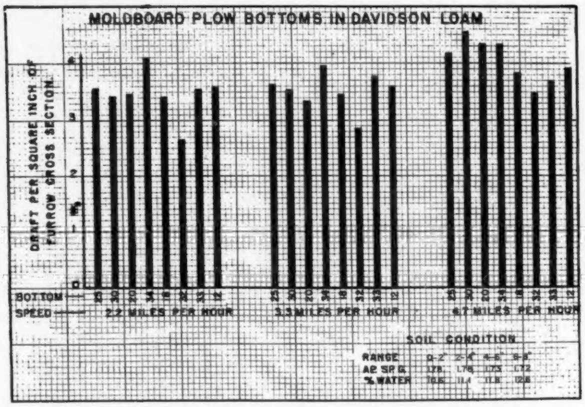


Fig. 6 (Left) Increase of draft with speed for two bottoms in two soils. Fig. 7 (Right) Influence of speed on draft of nine general-purpose bottoms in Norfolk sand. Bottom shapes vary in the extent to which they follow the general trend



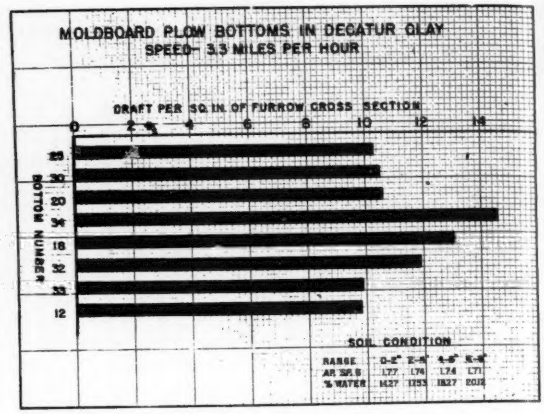


Fig. 8 (Left) Influence of speed on draft of eight general-purpose bottoms in Davidson loam. Fig. 9 (Right) Draft of eight general-purpose bottoms at one speed in Decatur clay

It will be noted in Table 1 that eleven of the sixteen bottoms listed are classified as general-purpose bottoms. The brief descriptions of these bottoms indicate that a number of them are very similar in shape but show also that some are called speed bottoms, that is, the designer developed them for speed above 4 mph. The next problem is to find how these variations within this class affect draft.

Figs. 7, 8, and 9 show the draft of nine different general-purpose bottoms in Norfolk sand and eight in the Davidson loam and Decatur clay soils. The condition of each soil is given in the respective figures. Bottom No. 30 is the only one of these bottoms that was used in the series of tests discussed in the first part of this paper.

These data show that the draft of bottoms 25, 30, 20, 33, and 12 is usually below or near the average for the group. The draft for bottoms 32 and 18 tends to stay below average, except in the heavier soil. The draft for bottom No. 34 is high or very near the top in every case. The contour drawings of these bottoms, Figs. 1 and 2, give an explanation for these variations in draft. Note that bottoms 25, 30, 20, 33, and 12 all have approximately the same clearance under the wing of the moldboard and that the upper part of the moldboard has about the same curvature. Bottoms 32 and 18 are open under the wing and the lower part of the wing of the moldboard is dropped back

TABLE 4. SOIL CONDITIONS FOR TESTS IN TABLE 2

Condition No.	0-2	2-4	4-6	6-8	0-2	2-4	4-6	6-8
	Apparent specific gravity				Per cent moisture			
	Norfolk sand							
1	1.60	1.72	1.71	1.66	7.78	8.5	8.9	11.2
2	1.65	1.71	1.71	1.71	5.2	5.8	6.4	8.0
	Davidson loam							
1	1.72	1.78	1.78	1.83	6.1	8.5	9.4	11.5
2	1.61	1.62	1.60	1.59	8.1	8.3	8.5	9.9
3	1.58	1.62	1.61	1.62	7.7	8.3	8.1	10.1
	Decatur clay							
1	1.40	1.55	1.58	1.64	11.3	14.9	17.1	18.4
2	1.81	1.59	1.56	1.61	13.0	14.8	15.5	17.4
3	1.53	1.51	1.50	1.51	16.1	16.3	17.1	17.8

(Range of depth of sample, in)

to facilitate the passing of the soil. This tends toward lower draft in the lighter soils but extreme curvature of the upper part of the moldboard causes higher draft in the Decatur clay. The draft for bottom No. 34 is high for the same reason that caused the draft of the sod bottom to be high. There is much less clearance under the wing of the moldboard than for the other bottoms in this group, and since the curvature of the upper part of the moldboard is very abrupt, especially from the 4 to the 8-in contours, the draft for this bottom is high for the Decatur soil also.

Discussion of Other Bottom Shapes. Bottoms 18, 33, 38, and 44 are shown in Fig. 10. Contour drawings of these bottoms are shown in Figs. 1 and 2. Three of these, 18, 33, and 38, fall within the general-purpose class, yet they are quite different in shape. Number 38 uses the same simplified share arrangement as No. 30 but has a more nearly conventional shaped moldboard. Bottom 33 uses a new type share and point arrangement, and the top of the wing of the moldboard is brought forward a little farther than for No. 38. This tends to make it handle the soil

TABLE 5. EFFECT OF SPEED ON THE DRAFT BOTTOMS No. 20 and No. 40 IN DAVIDSON LOAM AND DECATUR CLAY

Soil	Davidson loam		Decatur clay	
Bottom No.	20	40	20	40
Speed, mph	Draft in pounds per square inch of furrow slice cross section			
1.50	3.94	5.40	7.09	7.63
2.50	4.10	5.40	7.19	8.24
3.75	4.82	6.79	8.28	8.84
5.00	6.05	6.17	9.01	9.17
6.50	6.32	6.81	10.25	10.69

nicely for speeds up to about 5 mph. No. 18 is called a speed bottom. The lower part of the moldboard is relatively narrow and the top of the wing is brought forward about 3 in. This is to turn the furrow slice at high speeds without causing it to be thrown as far or as high as with bottoms of the average general-purpose shape.

SUMMARY

The data presented as a result of the two groups of tests made at the Farm Tillage Machinery Laboratory show that the shape of plow bottoms affects draft markedly. The effects of major shapes which cause the bottoms to be classed into the different types are shown first. The effects of shape variations within a class are then shown.

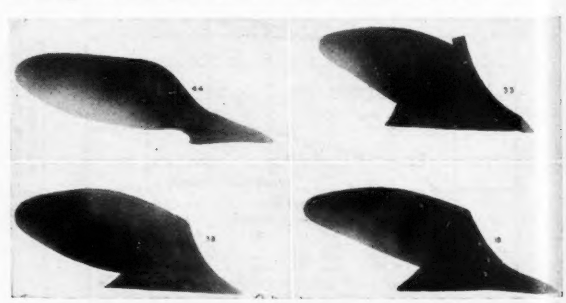


Fig. 10 Four types of plow bottoms. Nos. 33 and 38 are general-purpose, with simplified share arrangements. No. 18 is a speed bottom. No. 44 is commonly called the English type bottom

The Design of Farm Freezing Units

By Richard L. Witz

JUNIOR MEMBER A.S.A.E.

INDIVIDUAL farm freezing units have recently been introduced into Indiana, and to date owners of such units are well satisfied with the results.

About two weeks ago I called upon the user of one such unit, a Mr. Dyer, whose farm is located 5 mi west of Lafayette, where a 30-cu ft farm freezing unit purchased by Purdue University in July 1939, has been installed. The 25-cu ft storage compartment of this unit was opened to show the contents. It was practically full of frozen food. The 5-cu ft freezing compartment was then opened and that also was so full that the food could not have been placed in the storage compartment. On this visit I was accompanied by a representative of a manufacturer of a combination farm freezing unit in which the high temperature (35 deg F) storage space is about twice that of the frozen food (zero F) storage space. We both agreed that the sizes of the two storage spaces should be reversed.

In Indiana there are approximately 200,000 farms, and about 60 locker storage plants. Roughly they could serve from 5 to 10 per cent of the farmers, if used exclusively by rural people. This situation is somewhat typical of the entire United States. More storage space is needed for frozen foods.

The locker plant has been developed extensively in some parts of the country; in other parts it has not. It has offered the farmer a complete service for the storage as well as for the processing of food produced on his own farm. In some cases the farmer does not care to butcher, cut, and freeze his own meats. However, in other cases the farmer and his wife take great pride in preparing their own meats and vegetables. To many a housewife the privilege of preparing her own food on the farm has been a great joy.

The locker plant has often been too far away or in an out-of-the-way direction. This is important because the housewife usually needs food from the locker at times when her husband is busiest with farm work, and trips to the locker are expensive. For instance, if the locker plant were only 5 mi away, it would mean a 10 mi trip to obtain food. Suppose it were necessary to make only one extra trip in a week. In a year's time these trips would cost about $15, not taking account of the time lost. A farmer 10 mi away who made two extra trips a week, would have a pretty large item of expense and this cost would go a long way toward paying for a farm freezing unit.

Many other farmers complain that one locker in a locker plant is not large enough, and when they use more than one the expense is pretty high. This means that the locker is only partly supplementing the existing method of canning food on the farm. In other cases, the housewife is tempted to throw out small portions of food which otherwise could easily be frozen on the farm and put into a home freezing unit. This waste also in a year's time would become quite an item of expense.

Possibly these facts will help us to understand why the farmer wants a farm freezing unit, and why it is up to the agricultural engineer to provide some unit he can operate economically and be able to purchase at a reasonable price. We want a unit that is practical for him to use, a unit that is large enough, and one that will freeze and store his foods as well as a locker plant.

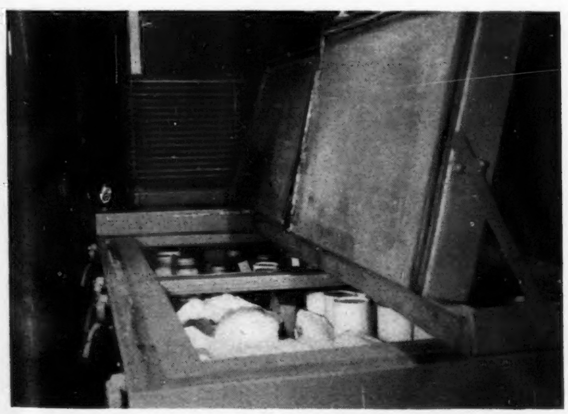
The first question that is asked by most farmers is, How large a unit do I need? An answer has been figured out by many people on the basis of the amount of food consumed by a person for a year. However, there is so much variation in the amount and kind of food consumed by a person or by a family that this, to my mind, has not proved satisfactory. I have been watching closely the size of units necessary for various sizes and types of families. The Dyer family, mentioned above, has a 30-cu ft box, which is probably twice as large as necessary for the three people which it serves. On this basis 5 cu ft of storage space per person are required. Another home-built unit which we have installed in the southern part of the state has 70 cu ft of space. There are two rather large families using food frozen in this box. It provides approximately 6 cu ft of storage space for each person. In general, we feel that 5 or 6 cu ft should be provided for each person in the family.

The size of the box needed can be reduced somewhat if the food supply is carefully planned. The family might butcher a 150-lb hog instead of a 225-lb hog, or four families could divide the carcass of a steer, each freezing only one quarter of a beef at one time. Such planning would aid materially in cutting down the size of the unit needed and, also, in cutting down the original cost of the unit.

Quick-freezing Equipment. The equipment necessary for quick freezing of farm products offers quite a problem. There are three ways to increase the rate of freezing: (1) by lowering the temperature in the quick-freezing compartment, (2) closer contact between evaporator coil and food, and (3) the size of the article to be frozen may be made smaller.

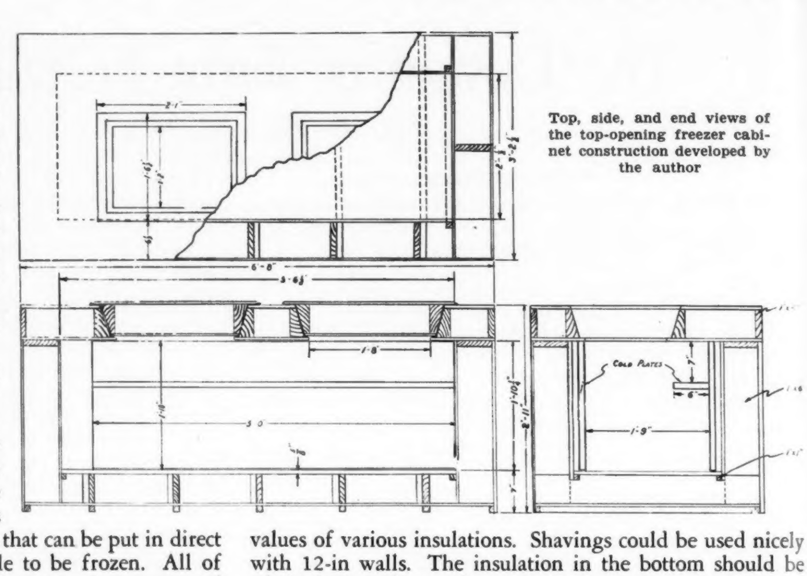
Reducing the temperature of the quick-freezing compartment is rather expensive and not altogether satisfactory, in that it is hard to regulate and keep the temperature in proper adjustment. This method has not proved entirely satisfactory. The same objective may be accomplished by lowering the temperature of the storage compartment and freezing the food directly in the storage compartment. This

A paper presented before the Rural Electric Division at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 5, 1940. Author: Assistant in agricultural engineering, Purdue University.



Storage compartment of the 30-cu ft individual frozen food unit purchased by Purdue University in July 1939

has been done in two cases in the state. One farmer is keeping his unit at –20 F. This temperature is held during the season when he expects to freeze and at other seasons he raises the temperature to around zero F. This process is recommended by at least one manufacturer. The one disadvantage of this system is that it costs about twice as much to operate at 20 deg below zero as it does at zero F. The amount of additional cost would depend on the cost of the electricity.



Top, side, and end views of the top-opening freezer cabinet construction developed by the author

In commercial freezing, several definite methods have been developed to increase the rate of freezing. Some of these methods include immersion of the food to be frozen in brine, spraying the food with the brine, and the use of two flat plates which contain direct expansion coils that can be put in direct contact with two sides of the article to be frozen. All of these methods increase the rate of freezing. In commercial lockers, quick freezing is important because of the time lapse between the household and locker plant, while on the farm little time need be lost between the garden and the freezing unit.

In farm freezing, we are getting rather satisfactory results by using a flat plate and placing the farm produce to be frozen on this plate. Another method is the use of a fan to circulate the air to get better contact with both the evaporator coil and the food to be frozen. A combination of these two methods may be used.

Freezing the food in small "meal-sized" packages makes it convenient to remove the food from the storage compartment. The smaller the package the faster will be the rate of freezing.

Construction and Insulation. In the unit which I have designed plywood has been used throughout. The outer walls are made of ordinary plywood while the inner walls, because they are likely to frost up at times, are made of waterproofed plywood. The framework is made mostly of 1-in boards; 6-in boards are used on the sides, and 5-in boards on the top and bottom. The joints are everyday lap joints and no special type of construction is used. Where possible, the side wall extends to the outer wall, which takes the place of one divider board or studding. Joints are reinforced with a 1-in square piece and are glued and screwed together.

Openings are at the top. The main reason for putting these on the top is to allow for cheaper construction and to prevent warping of the door. Side doors, unless well made, eventually cause trouble. Homebuilt side doors almost always cause trouble. The top door may be either hinged or just laid into the opening. Doors for the top are rather easily made and must be slightly smaller than the opening to take care of any swelling due to moisture.

An idea advanced by Michigan State College seems good. The entire top is bolted on and may be removed. The purpose of this is to make it possible to take the box through a doorway. By removing the top and turning the unit on its side it is possible to put it through a 30-in doorway. Even in homebuilt boxes, this is rather advisable in case the unit should ever be moved.

Any loose insulation may be used. The thickness of the side wall may be varied to take care of the insulating values of various insulations. Shavings could be used nicely with 12-in walls. The insulation in the bottom should be of the best quality to decrease the thickness required, making it possible to move the box through a 30-in doorway.

One thing that should be strongly emphasized is that there must be a good vapor barrier near the outside. One of the best vapor barriers is asphalt paper. This is cheap, and if properly installed, will make as good a vapor barrier as can be had. Two or three thicknesses are used, the joints being lapped, and each layer being cemented together with asphalt. This is extremely important in that, if this were omitted, moisture would accumulate in the insulation. Moisture in insulation will cut down the insulating value to some extent, but not as much as commonly thought. The maximum is about 30 per cent. However, moisture will cause deterioration in joints and materials of the structure. Another fairly good vapor barrier is aluminum paint. Two good coats of aluminum paint on the outside will help considerably in reducing moisture condensation in the insulation.

The freezing plate is located directly in the storage compartment. It is placed near the top and to the rear. Food may be placed on this plate while being frozen and then put down into the storage compartment. To maintain the temperature within the box there are two plates, one in the front and one in the back. These may be replaced by coils made of copper tubing. The dimensions of this unit are such as to meet the standard size plate of one manufacturer.

Plates in this unit are 5 ft long. This gives a storing space of 17.6 cu ft. The same sized plates may be purchased in lengths of 7, 9, and 11 ft. Each additional 2 ft adds nearly 6½ cu ft of storage space capacity. This gives possible sizes of 17.6, 24.0, 30.5, and 36.9 cu ft. The smaller sized unit can be operated with a ⅓-hp compressor, the next two sizes with a ½-hp compressor, and the larger unit will need a ¾-hp compressor. These sizes are about right for families of 3, 4, 5, and 6, respectively.

The amount of produce that can be frozen at one time will vary considerably with the outside temperature. Two methods may be used to increase the amount of food that can be frozen. During warm weather it would be possible to run water over the condenser coil to increase its capacity. Although not entirely satisfactory, it is also possible to place an ordinary household fan in the box when capacity for a large freezing load (Continued on page 109)

A Small Electric Milk Pasteurizer

By George J. Burkhardt and C. W. England

MEMBER A.S.A.E.

THE pasteurizer described in this article is of the batch type, using the standard holding method of heating to 143.5 F (degrees Fahrenheit) and maintaining that temperature for 30 min. The resistance of milk to the flow of an alternating electric current is used as the heating means. Designed for farm use, it will operate on any line with capacity sufficient to operate a 5-hp motor. The present unit has a capacity of 12 gal per batch with a maximum current demand of 31 amps at 220 volts.

This pasteurizer was developed especially for the small producer-distributors who supply fluid milk to our numerous villages and towns, many of which do not as yet enjoy the protection of pasteurization. Also, it should be well adapted to supply pasteurized milk for home consumption on large estates or corporation farms.

The development of this pasteurizer was started by the National Rural Electric Project in cooperation with the University of Maryland in 1931. After much of the basic work[1,2] had been completed, it was discontinued in 1933 due to lack of funds. Because of a growing apparent need for a unit of this type, the project was reopened by the Maryland agricultural experiment station in 1937.

The vat for this pasteurizer is a synthetic rubber ("Saniprene") lined steel tank 24 in long, 13½ in wide, and 10½ in deep inside, with the floor sloping toward a drain near one side and midway between the two ends. The drain has a poppet type valve with a soft synthetic rubber face, under a hard rubber cap on a stainless steel stem. The outlet is of stainless steel welded to the vat. The requirements of the vat are that it must be an electrical insulator and must not impart any flavor or odor to the milk. This vat was adopted after much study, correspondence, and experimentation covering stainless steel, glass, and glass and lacquer-lined steel tanks.

The electrodes are of graphitized carbon, ¾ in thick, 12 in wide, and 10 in high (Fig. 2). They are designed with insulated tops which hook the electrodes over the rim of the vat, thus holding them in place. On the present unit these insulators are made of strips of lacquered[3] hardwood. Any good insulating material with the necessary strength and resistance to heat and water could be used. These strips are set in lacquer and bolted to the electrodes to avoid unsanitary crevices. Spade electrical contacts are provided between the electrodes and the terminals in the cover.

The agitator (Fig. 2) is made of a block of lacquered hard wood, ⅝x1½x6 in, carved to shape and screwed to the end of a bakelite rod or shaft which is easily removable from the drive on the cover. This part could perhaps be molded in one piece from a suitable plastic. It must be a tasteless, odorless electrical insulator. The shape used was found to give adequate agitation with a minimum of churning.

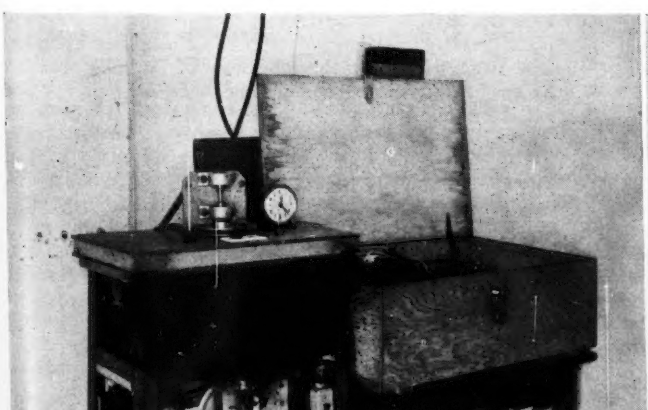
The agitator is driven at 130 rpm by a small electric motor mounted under the vat. The belt drive was used in the experimental model to provide flexibility in speed control. A gear reduction motor mounted on the cover could be used. The belt drive has advantages in that it reduces the weight on the cover and may at the same time reduce the cost. It also places the motor in a more protected location.

Paper No. 530 in the scientific journal series of the Maryland Agricultural Experiment Station. First publication in AGRICULTURAL ENGINEERING. Authors: Respectively, associate professor of agricultural engineering and professor of dairy manufacturing, Maryland Agricultural Experiment Station.

[1]Besley, H. E. A ten-gallon electric milk pasteurizer, N.R.E.P. Report M-11, 1932.

[2]Krewatch, A. V. Second progress report on the development of a small electric milk pasteurizer, N.R.E.P. Report M-17, 1934.

[3]Polymerized normal propyl methacrylate resin dissolved in equal parts of tolulene and xylene was used as a lacquer.



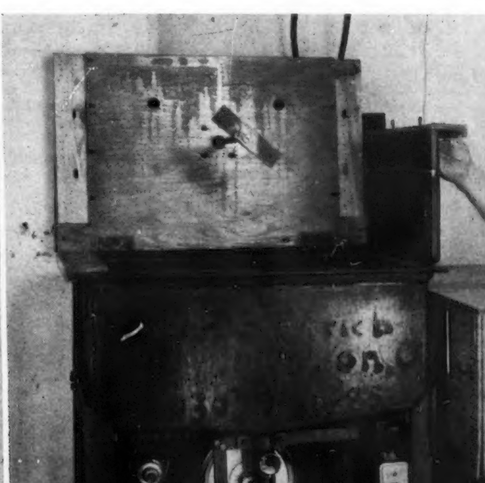


Fig. 1 (Above) Electric pasteurizer in operation. Fig. 2 (Right) Electric pasteurizer with cover open, showing agitator and electrode

The cover of the vat carries the agitator drive, the thermostat, and the electrical contacts. In the present model it is built of two layers of plywood with enough space between to build in the contacts and the wiring. The actual design of the cover would depend on the manufacturing processes available. It should have the basic principles provided in the present unit, with added durability and more sanitary construction. It might be molded in one piece from a suitable plastic, or it could be made of stainless steel with the necessary contacts set in.

Fig. 3 shows a diagram of the electrical circuit. Three-wire, 220-volt service is used. Power enters the unit through a two-pole, mechanically connected thermal breaker which can also be used as a switch. The power to the electrodes is controlled by a power relay which is, in turn, controlled by the control circuit. The agitator motor is controlled by a second two-pole breaker which is connected directly to the main line so that the agitator can be operated without closing the main circuit.

The control circuit operates on 110 volts. It consists of a thermostat and a specially designed sensitive relay[4]. The thermostat is much like a glass-stem mercury thermometer with electrical contacts into the mercury column. It is non-adjustable and maintains its original setting throughout its life. While it is quite fragile, its method of application is such that breakage can be reduced to a minimum. Any thermostat used must be itself an electrical insulator or must be enclosed in an insulating sheath. Enclosing the thermostat reduces the sensitivity to a point where it is difficult to maintain the temperature within the limits prescribed by law as the heating rate at the cut-off point is quite high. The present thermostat will maintain the holding temperature within a range of $\frac{1}{2}$ deg.

As the pasteurizer is quiet in operation, it was difficult to determine the cut-off point without watching the electrical instruments. A timing circuit was added, consisting of a mechanical latch-in, hand-reset relay and a self-starting electric alarm clock. Actuated by the sensitive relay, the mechanical latch-in relay closes the clock circuit when the power circuit is broken the first time. The clock then continues to run and times the holding period. In practice, before the pasteurizer was started, the clock was set at 12:00 and the alarm at 12:30. The alarm would then signal the end of the holding period. In the general din of the dairy plant the alarm was not loud enough always to be heard.

[4]The sensitive relay and thermostat were designed and built specially for this project by the Vapor Car Heating Company, Chicago, Illinois.

Certain features are embodied in the design to insure the safety of the operator from accidental electric shock. The contacts to the electrodes are located in the cover so the current is automatically broken when the cover is lifted, thus preventing shock due to contact with either the milk or electrodes should the switch be left on.

The drain is placed at the neutral point of the 220-volt circuit so that contact with milk leaking from the drain or flowing from the opened drain while the current is on would not cause shock. A heavy ground is supplied as an additional safeguard. To avoid current failure in one side of the line and the consequent unbalance, the mechanically connected breaker is used and no fuses of any kind should be used. Where fuses may be required by law, they should be so large that the breaker will trip first under all conditions.

Over 500 gal of milk have been pasteurized in the present unit in various tests to determine the physical, chemical, and bacteriological effects of the process. The results of these tests indicate that this is substantially a heating process and that when like temperatures and holding periods are used, the results compare favorably with those of a new 200-gal hot-water batch pasteurizer regularly used in the University dairy.

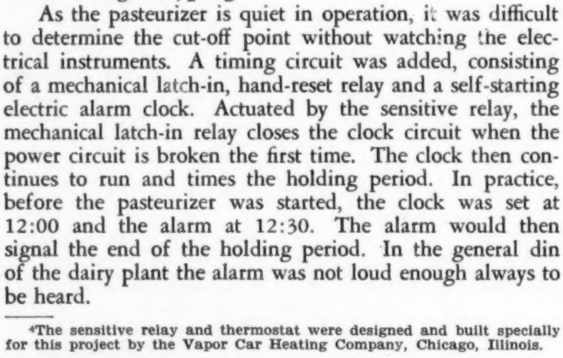
The results of one series of 30 tests, using from 10 to 12 gal of milk per test, are shown in Table 1. These data indicate that the electric pasteurizer is slightly more effective in destroying bacteria than the hot-water unit, but that the cream-line reduction is slightly greater.

Comparative Results of Steam and Electrical Pasteurization

	Raw milk	Electric pasteurization	Steam pasteurization
Average bacteria counts	192,866	4,170	4,990
Maximum bacteria counts	905,000	24,600	26,400
Minimum bacteria counts	24,000	260	340
Average per cent destruction		97.796	97.378
Average cream volume after 8 hr, per cent	17.66	16.03	16.23
Average cream volume after 24 hr, per cent	16.40	14.65	15.13
Reduction in cream volume per cent, 8 hr		9.23	8.10
Reduction in cream volume per cent, 24 hr		10.67	7.74
Average flavor score	20.06	21.02	21.02

Batches of from 2 to 12 gal have been pasteurized effectively with this unit. The time required for heating small batches is somewhat greater than for large ones. The efficiency is also somewhat lower.

Operating cost of the pasteurizer depends upon the cost of electricity, initial temperature of the milk, and size of the batch. Approximately 0.24 kw-hr are required during the holding period, regardless of the size of the batch.



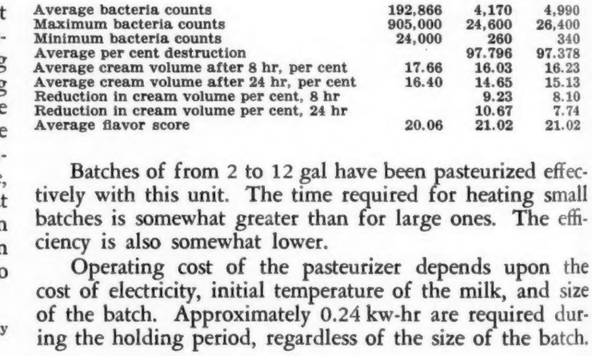


Fig. 3 (Left) Wiring diagram of the pasteurizer at present. Fig. 4 (Right) Recommended wiring diagram for automatic operation

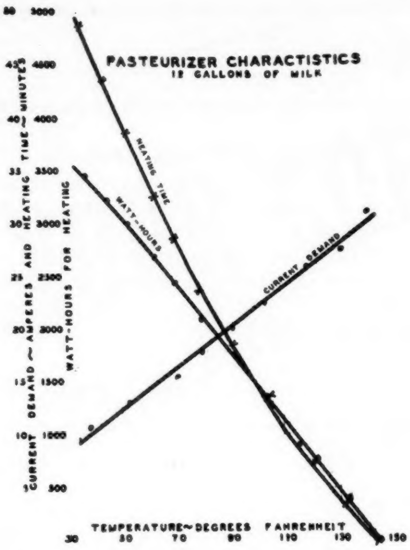


Fig. 5 Operating characteristics of the pasteurizer

This includes the power to the agitator. For a 12-gal batch the total cost would range from 0.61 cents per gallon, with a starting temperature of 38 F, to 0.33 cents per gallon, with a starting temperature of 90 F, using current at 2 cents per kilowatt-hour.

Holstein milk was found to heat slightly faster than Guernsey and Jersey milk, due to lower electrical resistance. The difference was very small.

Cream was found to heat approximately half as fast as milk. This lengthened the heating time to such an extent that the process would be impractical, except for occasional use. To adapt the unit for regular cream pasteurization, the vat should be shortened and its cross sectional area increased. This could be done where the pasteurizer was to be used for cream only.

Beside the design changes suggested in the discussion of the various pasteurizer parts, the following changes, based on several months of regular operating experience, would add to ease of operation and durability of the unit.

1 The entire relay system, including the breaker and motor switch should be located in one box and mounted on the dairy wall rather than on the pasteurizer, to reduce the water hazard in the washing process, and for convenience. Regular plug-in receptacles should be provided for both the power and thermostat circuits. A standard three-wire range cable would make an excellent power connection, using the third wire as a ground. The thermostat and motor circuits could be combined in a four-wire connection or used as two separate two-wire connections. It is important to have a special plug on the thermostat circuit so it cannot be plugged into a power line. A standard radio outlet might be used.

2 A more effective signal on the timing device would be desirable, as it would permit the operator to proceed with other work during the pasteurizing process. By using an electrical-reset instead of a hand-reset relay and a special timing clock (Fig. 4) with two contacts spaced at 30-min intervals, a standard electric bell could be used as a signal at the end of the holding period and the process of turning the clock back could be used to reset the relay. This system could also be used to shut down the pasteurizer automatically. The added cost of such equipment may not be justified.

Various sizes of this type of pasteurizer could be built, depending upon the limits of heating time and current demand imposed. The electrical resistance of milk varies inversely as the temperature. Fig. 5 shows the current-demand curve for the present pasteurizer. Fig. 5 also shows the time and electrical energy required to heat the milk from the various initial temperatures shown on the temperature scale to the final temperature of 143.5 F. An increase in capacity would require an increase in either heating time or current demand or both.

Approximately six months' experience in more or less regular operation indicates that the unit described is safe, workable, and efficient. Its operation is simple and convenient. The operating cost is low where average electric rates are available. No auxiliary equipment, such as a boiler, is needed.

The Design of Farm Freezing Units

(Continued from page 106)

is desired. This is not desirable, because it may raise the temperature of the food already stored in the box.

The unit which we have in operation at Lafayette has used approximately 1700 kw-hr of electricity during the past year. At three cents per kilowatt hour that amounts to about $54 for a year's operation. Three or four lockers in a locker plant and a couple of extra trips to town a week for the year would easily exceed this cost. This unit is of older construction and has only 3 in of insulation. The cost would be less on later models. There has not been one cent of repair to date and after starting the compressors the adjustments have not been touched. However, the door gaskets will have to be replaced in the near future.

There are now on the market several small freezing units. They have capacities of 4 to 10 cu ft. These units are not large enough to freeze food on the farm but should be used in connection with a locker plant by people who live close to the locker plant.

A Home-Made Planimeter

(Continued from page 94)

8 Mark point E by pressing on the planimeter as before. Points C and E will be close together, the distance between them depending upon how accurately the tracing has been done. In rare instances points C and E may coincide, indicating that the tracing has been exact. When C and E do not coincide, the error may be corrected by measuring the distance from D to a point midway between C and E. A scale divided in one-hundredths of an inch is desirable.

9 Multiply the distance obtained in step 8 by the distance between the points of the planimeter (10 in in this case) to find the area in square inches of the figure measured. Theoretically the distance should be measured along an arc of radius equal to the distance between the planimeter points. However, when the distance is small, the error due to the use of a straight scale will be negligible.

It is advisable to practice on regular figures such as squares, triangles and parallelograms of known dimensions until skill has been developed in holding the instrument lightly and in accurately tracing the outlines of the figures. It is best to use the average of three or more trials as the corrected distance to reduce the effect of mechanical errors in holding the instrument vertical and in following the line.

If the points of the instrument are protected with corks, it can be carried in a brief case or bag, and will not get out of adjustment.

NEWS

Pacific Coast Section Meets in Arizona

MACHINERY and irrigation were the phases of agricultural engineering emphasized in the nineteenth yearly meeting of the Pacific Coast Section of the American Society of Agricultural Engineers, held February 7 and 8 at Litchfield and Tucson, Arizona. This was the first meeting the Section has held in Arizona.

Opening in the community hall at Litchfield, the program offered papers on "The Evaporative Type Cooler," by M. L. and J. P. Thornburg of the mechanical engineering department, University of Arizona; "Large Unit Pumps and Engines," by H. C. Schwalen, discussed by C. N. Johnston; "Deep Tillage in the Southwest," by O. W. Sjogren; "Tractor Testing," by H. S. Manwaring; and "Latest Tires for Agricultural Use," by M. B. Riggs.

A luncheon meeting featured a talk on "The Southwest Cotton Company's Experiment in Establishing Young Men Farmers," by L. D. Klemmedson, Arizona state supervisor of agricultural education; followed by a round table on trends in farm machinery led by J. R. Cullison, assistant professor of agricultural education.

The afternoon was spent at the proving grounds near Litchfield, observing demonstrations of tractor testing, power lift, and deep tillage.

Saturday morning, February 8, the meeting reopened at the University of Arizona in Tucson. Dr. J. Byron McCormick, dean of the College of Law of the University, welcomed the group with a short talk. "Proposals and Plans for Water Utilization and Irrigation Development in Arizona" were explained by M. E. Bunger, engineer in charge of secondary investigations, U. S. D. I. Bureau of Reclamation. After an open discussion of this subject, C. A. Anderson, district engineer, San Carols Irrigation and Drainage District, presented "Problems in the Operation of Canal Systems, Methods and Costs." L. H. Mitchell gave an illustrated talk on "Saving Water in Transit," which was discussed by Byron J. Showers.

At the noon luncheon C. C. Huskison, resident engineer, Arizona Highway Department, gave an illustrated talk on "Earthquake Damage in Imperial and Yuma Valleys, May 18, 1940."

Papers on the afternoon program were "The Irrigation of American Egyptian Cotton for High Yields," by Karl Harris; "Soil and Moisture Conservation Measures and Their Effect on Water Supply in Arid or Semi-arid Regions," by James G. Lindley, discussed by W. W. Weir; and "Three Newly Developed Field Methods of Determining Soil Moisture and Need of Irrigation," by Joel E. Fletcher. A short business meeting followed this session.

A total attendance of 89 registered for the meeting. A telegram of good wishes to the Section was received from the Chairman of the Southern Section, which was meeting at Atlanta, Ga., at the same time.

Southwest Section Plans Dallas Meeting

A MEETING of the Southwest Section of the American Society of Agricultural Engineers has been planned for April 11 and 12, at Dallas, Texas. F. R. Jones, as acting chairman, will call the meeting to order for the election of a chairman pro tem.

Howard Matson will preside over a technical session during the balance of the morning. It will open with a symposium on "Recommended Soil and Water Conservation Practices in the Southwest." Those scheduled to contribute to this symposium are M. R. Bentley, E. L. Arnold, W. H. McPheters, C. J. Hutchinson, H. O. Hill, and E. C. Buie. Other items on the morning schedule are papers on "The Water Facilities Program in West Texas," by J. J. Coyle; "Runoff from Small Agricultural Areas," by J. H. Zabriskie; and "Construction of Channel Type Terraces with Various Types of Equipment," by P. M. Price.

In the afternoon H. T. Barr will preside over a session featuring papers on "Equipment for Pasture and Range Improvement," by S. A. Debnam; "Homestead Planning and Beautification," by E. L. Hazen, with discussion by E. B. Doran; "Farm Buildings for the Southwest," by Deane G. Carter; "Rehabilitation of Tenant Farmers and Reclamation of Marginal or Abandoned Farms," by Roy E. Hayman; "Recent Developments in Farm Refrigeration," by P. T. Montfort; and "National Defense Farm Shop Program," by M. F. Thurmond.

An informal banquet will be held in the evening, with F. R. Jones presiding.

Saturday morning, April 12, F. W. Peikert will preside. Papers scheduled include "Irrigation Pumping with Electric Power," by W. D. Scoates, with discussion by Kyle Engler; "Underground Water Supplies in the Southwest," by Harry P. Burleigh; "The Alkali Problem and Irrigation in the Southwest," by W. T. Carter; "Dehydration of Sweet Potatoes for Livestock Feed," by A. B. Kennerly and "Problems of Flax Production in the Southwest," by E. S. McFadden.

A business meeting of the Section will be held at the close of this session.

A.S.A.E. Meetings Calendar

April 5—Tennessee State Section, Knoxville, Tenn.

April 11-12—Southwest Section, Baker Hotel, Dallas, Texas.

June 23-26—Annual Meeting, Knoxville, Tenn.

Sept. 29-Oct. 1—North Atlantic Section, Jackson's Mills, W. Va.

December 1-3—Fall Meeting, Stevens Hotel, Chicago.

A Nation-Wide Farm Building Program

A STATEMENT under this heading, developing the proposition that "immediate planning to improve farm living and working conditions in difficult times ahead is highly desirable," has recently been issued by the Special Committee on Rural Structures Program of the American Society of Agricultural Engineers. Members of the committee are E. W. Lehmann, chairman; Ray W. Carpenter, vice-chairman; Wallace Ashby, secretary; D. G. Carter, K. J. T. Ekblaw, Ray Crow, Henry Giese, B. B. Robb, R. G. Ferris, F. W. Duffee, Don Critchfield, Kirk Fox, J. D. Long, C. E. Seitz, and W. G. Kaiser.

Needs of more adequate housing for health and morale, of economic employment for rural population in excess of those needed in crop production, and of plans to cushion the shock of unemployment which would follow the sudden closing down of defense industries, lead to the assertion that "the rehabilitation of farm buildings, including farm housing, offers one of the soundest and most needed projects that could be undertaken to contribute to the general wealth of the nation."

Improvement needs, estimated in terms of facilities most farms lack, repair requirements, deferred and routine maintenance, remodeling, new houses needed, number of farms needing other buildings, and floor space requirements for such buildings are presented as the basis of a further estimate that a billion dollars per year in farm building investment is a reasonable objective by which farm buildings might be brought up to requirements in the course of 10 to 15 years.

In relation to other factors in the farm economic situation, this billion dollars is indicated to be 2 per cent of the 1930 Census valuation of farm real estate, less than twice the average yearly farm expenditures for operating automobiles, less than 10 per cent of the annual farm income expected in 1942, an increase of $600,000,000 over present expenditures, an increase of $90 per farm for all farms or an increase of $150 per farm not mortgaged, and well within farm ability to finance without subsidy.

A lack of adequate technical advice and assistance is indicated as the real reason for neglect of building by farmers.

Recommendations for stimulating farm building to bring it up to the billion-dollar-a-year level include competent, free architectural and engineering help to farmers who want to build; training in the building crafts for rural men and boys, to enable them to do a larger proportion of the work; help in using materials and labor available on or near the farm, so that more of the farmer's building dollar may be spent for finish materials and manufactured accessories, giving him more building value for whatever money he may be prepared to invest; help to the rural building tradesmen as to farm structural requirements and improved construction methods; building schools and demonstrations to spread interest in good buildings and building methods; and research to further apply technology to the solution of farm building problems.

As to financing, it is pointed out that the program would reach most easily and effectively farm owners with good credit and long-term tenants of owners who will share in financing improvements; that low-interest loan sources are (Continued on page 112)

A Nation-Wide Farm Building Program

(Continued from page 110)

available; that migrant workers, share croppers, and short-term renters might be helped through the Farm Security Administration; and that the program would furnish employment to many of the low-income group, giving them more means of meeting their own building problems.

To put the program in effect, it is recommended that the facilities of the U. S. Department of Agriculture and of the state agricultural colleges for extension and research in farm structures be expanded; and that the cooperation of the building materials industry be enlisted. It is estimated that this expansion, when fully developed, should put 1500 to 2000 men into this work, at a cost of about $1 per farm, with about two-thirds in extension work in direct contact with farmers, and the rest in research and administration. Each local extension worker would cover a field of 5000 to 6500 farms.

An immediate start is recommended to permit gradual and consistent development of personnel and methods in the interest of high standards and economy, to be ready when a period of unemployment demands action, to familiarize farm people with the help offered, to iron out details of the program, and because there is an immediate need of farm building improvement.

Supplementary information supporting the statement deals with accomplishments of the Extension Service, extension work with negro farmers, construction work of CCC, viewpoints on home values, and need of training in crafts.

The committee has prepared this statement as a means of spreading information on the need, problems, and possibilities of farm building improvement, and to present one definite suggestion and example of an economic peacetime activity which can be developed and ready to use the services of labor and industry when they are again released from defense activities. Any interested person who has not yet received a mimeographed copy of the statement, or who wants an additional copy or two to bring to the attention of others, may obtain copies from the headquarters of the American Society of Agricultural Engineers, at St. Joseph, Mich.

Tennessee State Section to Test Annual Meeting Trip

A FEATURE of the Tennessee State Section Meeting, Saturday, April 5, will be a bus trip to New Found Gap in the Smoky Mountain National Park. This will be an advance test carrying out in detail plans made for a similar trip as a feature of the A.S.A.E. annual meeting at Knoxville in June, calculated to train guides for that trip, check timing, and reveal any possible opportunity for improvement in plans for the trip as an event of the annual meeting.

Starting from the campus of the University of Tennessee at 12:30 p.m. with box lunches, the group will go via Gatlinburg, where it will be joined by an official of the Park. After lunch and sight-seeing at the Gap, they will return to Gatlinburg, with stops at interesting points enroute. The evening meal will be at a hotel in Gatlinburg, after which the group will return to Knoxville.

At the morning session of the Section meeting, starting at 9:00 a.m. in the new agricultural engineering building at the University farm, the program will include talks on "Observations on the Workings of an Electric Cooperative Association," by Ed. Babelay; "National Defense: Present Status of the Training Work for Out-of-School Youth," by M. A. Sharp; and "University of Tennessee Agricultural Extension Buildings Plan Service," by G. E. Martin. If time permits, the agricultural engineering department will show its new building to those present and indicate some of its plans for the future.

Chemurgists Offer Defense Program

"CHEMURGY in defense and beyond" is the theme announced for the seventh annual Chemurgic Conference, to be held March 26, 27, and 28 at the Stevens Hotel, Chicago, Ill., under the sponsorship of the National Farm Chemurgic Council, Inc.

Several members of the American Society of Agricultural Engineers will contribute to the program. Arnold P. Yerkes will preside over a session on "Chemurgy and Defense," Thursday morning, March 27. Fowler McCormick is to preside over the concluding session, Friday evening, March 28, dealing with "Opportunities for Tomorrow." L. F. Livingston will address that session on "A Glimpse of Tomorrow."

Some other titles suggest that the talks may be of interest to agricultural engineers, by reason of dealing with engineering materials used on farms or industrial requirements for organic raw materials which farms might meet economically with the help of engineered methods and equipment. They are "Drying Oil Requirements," by Ernest J. Trigg; "The Possibility of Vegetable Tanning Materials as a Chemurgic Project," by Fred O'Flaherty; "A Big Field of Small Items: Essential Oils, Spices, Drugs, and Specialties," by Paul Kolachov; "Sulfur Chemurgic Defense," by P. D. Peterson; "Chemurgy of Cotton as the Plantation Operator Sees It," by W. M. Garrard; "The Farmer's Viewpoint (on paint)," by B. G. Perkins; "The Farmer Uses Paint," by Walter W. McLaughlin; "Regional Laboratories Progress Report," by Henry G. Knight; "Chemurgy in Soil Defense," by Eugene M. Poirot; "Soybean Production from a Grower's Standpoint," by J. B. Edmondson; and "Soybean Production from a Processor's Standpoint," by Walter Flumerfelt.

Necrology

Harry Garfield Davis, director of research of the Farm Equipment Institute, passed away February 21, while attending the national farm institute at Des Moines, Iowa. He was 64 years old.

A varied early career in farming, business, and journalism led to Mr. Davis becoming editor of the Northwest Farm Equipment Journal in 1924. This gave him a wide acquaintance in the farm equipment industry, and in 1932 he was employed by the Farm Equipment Institute to direct its research activities. In this work he travelled extensively and made contacts with practically all of the agricultural engineers in farm power and machinery work in the United States. He became a member of the A.S.A.E. in 1937.

Many younger members of the Society will remember him especially as the representative of the manufacturers cooperating in the A.S.A.E. Industry Seminar. In this capacity he had a large part in planning the program and arrangements, and in supervising their execution he showed a keen personal interest in the comfort, convenience, safety, and instruction of every person attending. In spite of his responsibility for this mass of detail, he managed to find time to become personally acquainted with every student and instructor present. More than any other one man, he was the moving spirit responsible for the success of the seminar for the three successive years in which it has been held, and had well-advanced plans for the seminar this year.

Mr. Davis was also well known as a keen student and exponent of the economic and social advantages of mechanical and other technological progress. Another indication of his interest in farmers and in the improvement and use of machinery as an aid to their progress was his continuous study of farm accidents and accident causes. With him it was an absorbing hobby related to his work, and the information he collected proved useful in helping farm equipment manufacturers improve the safety provisions built into their equipment, as well as their precautions as to methods and practices for the safety of the user.

In recent years Mr. Davis regularly attended meetings of the Society and showed an active interest in the work of its Power and Machinery Division. Only two weeks before his passing he had attended and addressed the meeting of the Southern Section at Atlanta, Ga.

Mr. Davis is survived by his widow, Elizabeth, and a married daughter residing at St. Paul, Minn.

LeBaron Turner, president, U. S. Wind Engine and Pump Co., Batavia, Ill., passed away January 21. He was 58 years old. After graduating from the Massachusetts Institute of Technology in 1905, his engineering career included employment with the U. S. Wind Engine and Pump Co., from 1906 to 1916 in the successive capacities of engineer, superintendent, and second vice-president; and from 1930 to the time of his passing as vice-president and president. He was well known in the farm equipment industry and had been a member of the American Society of Agricultural Engineers since 1938.

Personals

Harry L. Garver, O. A. Brown, and R. B. Gray are contributors to "Electric Motors for the Farm," published by the U. S. Department of Agriculture as Farmers' Bulletin No. 1858.

B. L. Hagglund has been promoted to the position of assistant sales manager, western division, Caterpillar Tractor Co., with headquarters at San Leandro, California. Previous to his promotion he was western division representative.

E. L. Hansen, assistant in agricultural engineering, University of Illinois, has an article, entitled "Stabilized Soil for Buildings," in "Engineering News-Record" for January 2, 1941, which may be of interest to a number of agricultural engineers.

(News continued on page 114)

Personals

(Continued from page 112)

A. D. Longhouse is on leave as instructor in farm mechanics at West Virginia University to serve as a special representative for agricultural education in connection with the 4-A features of the national defense program. The territory to which he is assigned includes all of New England, New York, and West Virginia.

Earl S. Patch, sales manager, Moraine Products Division, General Motors Corporation, recently presented an interesting and informative paper on the applications and limitations of powder metallurgy before the American Society of Metals.

C. K. Shedd, J. B. Davidson, and E. V. Collins are joint authors of "Machinery for Growing Corn," published as U. S. Department of Agriculture Circular No. 592.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the February issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Edwin F. Babelay, instructor, agricultural engineering department, University of Tennessee, Knoxville, Tenn. (Mail) RR No. 6.

George Rosbolt Fisher, camp engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 303 S. 11th Street, Clinton, Okla.

Robert J. McCall, Agricultural Engineering Department, Ohio State University, Columbus, Ohio.

Walter F. Streblow, chief engineer, Tractor Division, Allis-Chalmers Mfg. Co. (Mail) 7107 W. Wisconsin Avenue, Wauwatosa, Wis.

TRANSFER OF GRADE

Samuel J. Baldwin, clerk, Census Bureau, Washington, D. C. (Mail) 605 21st Street, N.W. (Junior Member to Member)

Ormann R. Keyser, county agricultural agent, agricultural extension service, Ohio State University. (Mail) Room 216, Post Office Building, Canton, Ohio. (Associate to Member)

Thurman P. Powell, camp engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Camp SCS-0-8, Stanfield, Ore. (Junior Member to Member)

Robert G. White, head, regional records and statistics section, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 2977 N. Bartlett St., Milwaukee, Wis. (Junior Member to Member)

Student Branch News

PENNSYLVANIA

By Karl H. Norris

THE Penn State Student Branch of the A.S.A.E. has elected the following as officers for the coming year: President, Karl K. Norris; vice-president, Mark E. Singley; secretary-treasurer, Harry I. Hofmeister; scribe, William C. Stephens; faculty advisor, E. W. Schroeder.

Mr. Corson, a Penn State graduate of 1936, now associated with the Allis-Chalmers Manufacturing Co., was the speaker for the evening. Plans were outlined for an alumni homecoming sometime in May.

At the other meetings held during the past semester the speakers were: D. W. Rice of the National Electrical Products Co., and A. W. Clyde and J. E. Nicholas of the agricultural engineering department.

Last month the agricultural engineering department held an "Open House" to show just what was being done with the new building and new equipment that was put into use last year. The students and faculty cooperated to show everything off with success.

SASKATCHEWAN

By E. A. Olafson

WEEKLY afternoon meetings of the Branch, in accordance with previous plans, were devoted to student public speaking and, where necessary, to short business meetings. Students speak upon any topic of their choice. The idea behind the arrangement is to increase proficiency in public speaking, which we all realize is important professionally.

At the regular monthly evening meeting, representatives of the Branch who attended the A.S.A.E. Seminar in September, 1940, reported on their experiences.

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Student Branch News

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GEORGIA

By Bill Strauss

GEORGIA'S Student Branch of the American Society of Agricultural Engineers held two meetings during the month of February. The first was held on February 10.

At this meeting a sponsor for the Branch was elected to represent it at the 4-H Club Carnival to be held February 28, here at the University.

Talks were made by students and professors who attended the annual meeting of the Association of Southern Agricultural Workers. Nearly every member of the Branch went to Atlanta to attend the meeting.

The Branch was given charge of a booth at the 4-H Club Carnival. W. D. Kenney, G. H. Kimbrell, and J. W. Holliday were in charge.

J. W. Holliday, editor, reported that the annual, "Ag Engineer" was nearly ready to go to press, and expressed his thanks for the contributions of articles made by the students.

The second meeting was held on February 24, 1941. This meeting was devoted entirely to a "Question and Answer" program put on by the program committee. Small prizes were given to those who answered correctly. Every type of question was asked, including technical questions on agricultural engineering.

A painting of former Chancellor David C. Barrow, for whom the agricultural engineering building is named, was presented to the department by Dr. Harmon W. Caldwell, president of the University, on February 26. The painting will hang in the lobby of Barrow Hall.

Problem of the Low Producer

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Some have been victims of one or more serious mistakes made by themselves or others in choice of land, handling of land, choice of items to be produced, unwise investment, and other matters beyond their control which have taken from them the means of farming effectively. Some are victims of poor living habits and conditions which limit their energy, ambition, and application to their work. Some may be overconservative, self-satisfied, prejudiced, unadaptable, uneducated, untrained, uninformed, unprogressive, unethical, uncooperative, or otherwise limited by their outlook on their work. Some may have been victims of ill-advised recommendations of some agricultural engineer!

Some are unsuited to the job of managing any production enterprise of their own, but know one or more lines of farm or other work, and could be effective workers as employees of an effective manager.

Some few are misfits in agriculture who might be self-supporting in some other occupation. And a few unfortunates will be unproductive, dependent misfits anywhere. But even they have children whose future productivity is a concern of society.

Obviously, many technological aids to effective production, which these low producers might use to increase their effectiveness, are already available and proven in use by the more effective, self-supporting, and prosperous producers. More are being developed daily. Some represent too large an investment, or are not adapted to the scale of operations of the one-horse or one-mule farmer. Others cost little more than the effort necessary to change habits and practices. Enough are usable by the low producer to go a long way toward enabling him to be fully self-supporting. From this it seems that the progress of the low producer depends more on his becoming adapted to the use of aids provided by technology, than on the need of further adapting aids to his specialized requirements. Aids to production cannot be made foolproof, but our whole educational system is based on the proposition that most people have an undeveloped potential capacity to make better use of their opportunities. *(Continued on page 118)*


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Problem of the Low Producer

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It is apparent too, but sometimes forgotten, that recommendations as to how a low producer can improve his effectiveness must be conditioned according to his personal limitations, the reasons for his low level of production, the limiting factors in his capacity. Before he can use a tractor or an electric motor to increase his work effectiveness he may need a ten-cent account book, a bathtub, more vitamins in his diet, or a little experience in using two mules instead of one.

A related consideration sometimes overlooked in social experiments and by technologists engaged in extending the application of their technology, is that the individual can generally be helped best, not by attempting suddenly to revolutionize his whole life, but by information and encouragement aimed to get him to take first one then another step forward in increasing his effectiveness as a producer.

Preferably, that first step may well be in that element of his life and work which is estimated to be the most limiting factor in his present effectiveness. Or if his confidence must first be gained, it may be best to start with the improvement which may show quickest and most visible results advantageous to him, or with the activities in which he may be most responsive to help by reason of his interest and ability, or of the ease with which improvement may be made.

As a technology, agricultural engineering is mainly concerned with improving physical, structural, mechanical, and electrical methods and agencies as aids to effective production and effective living in agriculture. Since it is a specialized technology and cannot attempt to correct all of the many and varied causes for the low production efficiency of many farmers, cooperation with other branches of technology is indicated. In many cases the low producer will have to be led to progress in some other matters before agricultural engineers can lead him into increased and more effective use of engineered aids to production efficiency. In other cases the agricultural engineer may have to work with him before other specialists can give him much help. Oftentimes, and especially in analyzing the low producer's problems, the circumstances may require correlated parallel action by several different technical specialists.

Admittedly, the low producer who most needs the help of technology is also the most difficult to help. Both public service and commercial extension technologists perpetually face the question of how far they may be justified in going to help the low producer. Will he respond enough to be worth the effort, in terms of becoming less of a burden on society, or a better potential customer? Or will the same investment in extension service, applied to some more responsive individual, help him enough to make it easier for him and the rest of society and industry to carry the load of the low producer as a permanent liability? How low a level of responsiveness can extension men hope to work with, considering means and personnel available, in order to render maximum service?

Wherever the line is to be drawn, there are certain points agricultural engineers can emphasize to all concerned.

If a man is a low producer, it is generally because he is not using properly or sufficiently the knowledge and material aids to effective production which have been provided by technology and industry.

If he fails to produce enough to be fully self-supporting, he is inevitably a burden on society and industry. In some cases it will cost less to help him become more self-supporting than to let him continue as a liability.

Many of the low producers in agriculture are capable of responding to encouragement to improve their effectiveness. The extension problem *(Continued on page 120)*

Problem of the Low Producer

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is one of leading them to take whatever successive steps they can in the right direction. The problem of deciding what steps should be taken and the order in which they should be taken should be worked out by cooperation of extension specialists in all of the technologies of agriculture.

Since it is the thought and actions of individuals which must be modified, and this takes time, more can be accomplished by leading a large number of low producers to slow but steady improvement, than by trying to high-pressure a few into revolutionary progress. There is no scarcity of low-producers needing the help made available by technology.

Literature Received

CORN BREAD AND CREEK WATER, by Charles Morrow Wilson. Cloth bound, 309 pages, 5½x8½ in, 22 illustrations. Bibliography and index. Paraphrased as "The landscape of rural poverty," this work is granted by the author to be an incomplete and imperfect study of a problem which cannot be done full justice in writing. As a biography of poverty it presents an interesting picture from much first-hand observation of certain rural problem areas in the United States. This reviewer can give the author a better score on the recording of his observations than on his interpretations and implications as to causes and effects. Probably no reader will entirely agree or disagree with all of what Mr. Wilson has to say. Agricultural engineers will find themselves generously ignored, and various of their works and ideas variously condemned and praised. Those which are condemned share place with numerous other factors indicated as contributing to rural poverty. Structurally, the book is divided into three parts, with six chapters on "Anatomy of Rural Poverty," eight on specific rural poverty groups, and two on what is being or can be done about it. In conclusion, it indicates that rural poverty may be unavoidable, but that degrading extremes of rural poverty can and must be avoided. As a contribution to that cause, this book should be considered a reference springboard, rather than as gospel or even the outline of a program. Henry Holt and Co., New York and San Francisco, $3.00.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

WANTED IMMEDIATELY—College graduate with real mechanical aptitudes to serve as supervisor of industrial training in our American Agricultural and Industrial School in Liberia, West Africa. He must be able to handle maintenance and repairs of auto and gas engines and industrial equipment, also simple building construction, including plumbing and electric wiring. Because of the requirements of the Selective Service Act he must be able to secure exemption from this service or be beyond the ages included in it. He must have missionary motive and spirit and be able to work harmoniously with others, including those of the Negro race. Three-year contract. For particulars apply to Booker Washington Institute Trustees, Room 1410, 101 Park Avenue, New York City.

AGRICULTURAL ENGINEER wanted, preferably a young graduate with excellent scholarship and of the inventive type, and one who has had considerable training in electrical engineering along with his agricultural engineering, and with a background of farming experience and interest in the improvement of farming equipment, to assist in a new project being set up by an agricultural engineering department of a state university in cooperation with a utility company to conduct a 2-year's study of the use of electric power in field operations. PO-127

POSITIONS WANTED

AGRICULTURAL ENGINEER, 1940 graduate of University of Illinois, majoring in soil and water conservation, drainage, and structures, desires position anywhere in the United States. Automobile. Good references. PW-333